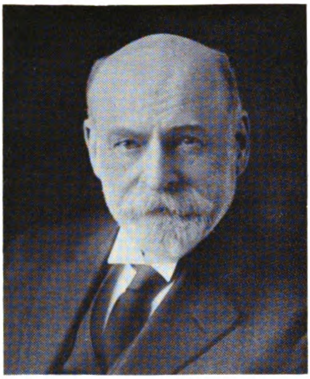
Report of the state mineralogist of California from ...

California State Mining Bureau



SECOND REPORT

OF THE

STATE MINERALOGIST

OF CALIFORNIA,

From December 1, 1880, to October 1, 1882.

SACRAMENTO:

STATE OFFICE : : : J. D. YOUNG, SUPT. STATE PRINTING.

1882.

CORRECTIONS.

The following are the most important corrections to be made in this publication; a number of verbal errors of less importance will be apparent to the reader:

Page 12, line 53, for "1882" read "1883."
Page 20, line 16, for "198,652" read "262,025."
Page 20, line 18, for "2,423" read "2,623."
Page 25, line 3, for "2,672" read "2,762."
Page 25, line 3, for "17,874" read "17,894."
Page 25, line 11, for "253,261" read "288,525."
Page 26, line 10, for "53" read "5."
Page 26, line 11, for "196" read "193."
Page 83, line 1, for "trellisses" read "trestles."
Page 88, line 14, for "eight tenths" read "eight tenths per cent."
Page 116, line 12, for "twenty-four inches" read "twenty-four-hour inches."
Page 116, line 24, for ";" read ","
Page 163, line 12, for "running" read "mining."
Page 176, line 2, for "1881" read "1880."
Page 219, line 27, for "lixivation" read "lixiviation."
Page 221, line 11, for "land" read "line."
Page 235, line 18, for "Annicola" read "Amnicola."
Page 237, line 19, for "but by the aneroid" read "but the aneroid."
Page 270, line 13, for "Actinophæni" read "Actinophænia."
Page 280, line 7, for "towns" read "terms."
Page 20, line 13, substitute these figures in place of those given:

10,054	9,705	13,259	6,843	10,369	11,405	3,280	64,915

Page 25, line 10, substitute these figures in place of those given:

11,965	12,468	13,331	14,026	14,233	13,138	13,173	92,894

Page 129, line 45, insert foot note after line 45.

With Compliments of

HENRY G. HANKS,

State Mineralogist.

To his Excellency George C. Perkins, *Governor of California :*

Sir: I have the honor to submit, herewith, my Second Report on the progress of the California State Mining Bureau, with Appendices.

HENRY G. HANKS.
State Mineralogist.

San Francisco, October 1, 1882.

REPORT OF THE STATE MINERALOGIST.

The first report of the State Mineralogist was sent to the Governor December 1, 1880. Much progress has since been made in carrying out the provisions of the Mining Bureau bill, approved April 16, 1880.

When the rooms, No. 313 Pine Street, were taken, it was understood that the location was temporary, the owners expressing their intention to rebuild the premises. Possession was given for six months only, but the Mining Bureau was allowed to occupy the rooms for one year. On the thirty-first of May, 1881, notice was served on the State Mineralogist to vacate within one month from date. In the meantime, museum and office material had accumulated to such an extent that their removal was a matter of considerable labor and inconvenience. Search was made for new rooms, and advertisements inserted in the daily papers, but the requirements of the Bureau were such that suitable apartments could not immediately be found. Although not wholly satisfactory, the present location, No. 212 Sutter Street, was selected as the best offered, and steps taken for removal.

The new rooms consist of three well appointed offices on the second floor, with a large and well lighted museum-room above, all of easy access and provided with private entrance and wide staircases. At the time of removal, the upper floor was partitioned into small rooms which required alteration to fit it for the use of the Bureau, pending which, it was found necessary to pack all the specimens in boxes and to store them, with the plate glass cases, in a fire-proof basement, a labor of no small magnitude. Immediate possession was, however, taken of the offices, and the business of the Bureau was conducted as usual. Six weeks elapsed before the museum-room was ready, when the cases were placed on the floor, the boxes unpacked, and the specimens rearranged; this labor required nearly two months, and retarded the progress of the museum to that extent.

A rough but convenient laboratory was fitted up for the determination of minerals sent in for examination, in which a great deal of chemical work has been done. Soon after the new rooms were fully occupied, the Mining Bureau fund, which at first was ample, began rapidly to diminish, and to such an extent that it became necessary to materially reduce the expenses; the Chemist, Janitor, and Secretary were suspended in succession, but it being found impossible to wholly dispense with the services of the latter, an arrangement was made with him to be at the Bureau on alternate days, with reduction of half salary. Owing to the same cause, it was impossible to give the information (except to a limited extent) so frequently asked, and which correspondents had learned to expect. Reference to the financial report will show the rapid diminution of the fund.

Expenses were reduced to the lowest possible point, and it being impossible to purchase more cases, attention was given to specimens rapidly accumulating, which were classified, labeled, and entered in the catalogue, ready to be placed in museum cases when the state of the fund would admit of their purchase. In this way a very large amount of material has been received and prepared for exhibition which does not appear in the museum.

A catalogue of the first year's collections, amounting to 3,000 in number, has been prepared and is ready for distribution. The number of specimens entered and ready for the museum is now 4,147, and there are at least 2,000 more not so entered, but in process of classification.

The museum is growing more rapidly than is generally known or could be expected; specimens are flowing in from every part of the State, and also from other States and Territories of the Pacific Coast. Besides these, many valuable specimens have been obtained by exchange with other States of the Union and with foreign countries.

The establishment of the State Mining Bureau has developed, or rather made manifest, the want of a first-class chemical and metallurgical laboratory, in which analyses of ores, minerals, mineral waters, rocks, building stones, and other mineral deposits of the State should be made, and the results published for the benefit of the people of the State directly, and the world at large indirectly. If such a laboratory should be provided, to be under the charge and control of the State Mineralogist, and in which at least three chemists should be employed, the benefit to the State would be beyond calculation. The assistant chemists should be graduates of the University of California, to whom a small salary should be paid, and employment given for a term not to exceed one year; their places to be taken by other graduates each succeeding year, and to those only recommended by the faculty or Professor of Chemistry of the University. By such a plan three distinct objects would be gained—the State would derive the benefit of their work; the young men would have an opportunity to make a practical start in the world, and the desire to hold so honorable a position would be an incentive for them to do well in their studies.

Another important matter for the State to consider is the danger of fire in the present premises. The present and prospective value of the collections is much greater than can be known by those who have no experience, and the loss to the State, should they be destroyed by fire, would be irreparable, as many of the specimens could not be duplicated. It would be well, therefore, to consider their immediate removal to a less exposed and better building.

It is also very important that a Board of Trustees or Advisory Committee of prominent citizens should be appointed to share the responsibility of the museum and library, (which is now too much for one individual to take), leaving the State Mineralogist free to travel over the State, to investigate new discoveries, report on them, and conduct the scientific departments with his assistants. The Mining Bureau bill should be so amended as to provide for the proper maintenance of the museum, for if the condition of the fund should remain as at present it will be impossible to conduct the institution on the basis upon which it has been commenced.

The State Legislature of 1881, passed a joint resolution transferring the collections at Sacramento to the Mining Bureau at San Francisco, but when application was made for it, the question was raised as to whether a joint resolution of one Legislature could annul an Act of a previous one. This question being unsettled, the State Mineralogist was advised to leave the collection undisturbed until the meeting of the next Legislature.

The Capitol collection would be a great addition to the State Museum at San Francisco, as it contains many magnificent and interesting specimens; and it is to be hoped that the expressed wishes of the last Legislature will not be thwarted by a mere technicality.

During the year 1882, the Mining Bureau met with a serious loss, the result of well planned robberies. The first occurred on the eighteenth of January, during the daytime. A single specimen of placer gold (No. 2066), from British Columbia, was taken from the case. The specimen was worth at least $15, and was still more valuable as a type of the placer gold from that locality. The second robbery was at night of January 24th. The burglars came over the roof and down a ladder to the platform in the rear of the museum, and entered in by a back window. They stole a number of gold specimens, including crystallized gold (No. 2853) from Tuolumne County, and half an ounce of placer gold (No. 3008), from Jenny Lind, Calaveras County. On February 24th, a large collection of gold specimens from a loan collection, belonging to the Honorable John Daggett, were taken from a case in the private office of the State Mineralogist. The case was broken open and the specimens taken from the drawers. The intrinsic value of the specimens stolen was at least $200. In the night, March 5th, the last robbery took place, on which occasion nearly all the gold specimens in the cases were stolen, including the beautiful specimen from the Idaho mine, Grass Valley (No. 1399), which attracted so much attention at the Paris Exposition of 1878.

The Police Department made every effort to trace out the robbers, and for more than two months kept detectives in the building and on the outside, but failed to discover the thieves. The department deserve special credit for the interest taken in the matter, for the officers certainly did everything in their power. The specimens, all being gold, were probably sent to the melting pot, and it is not likely they will be recovered. This experience may be regarded as a lesson, showing the importance of having the museum placed in a more suitable building.

As the condition of the fund would not admit of the employment of a night watchman, a burglar-proof safe was hired at a small rental, in which all extra valuable specimens have since been kept.

In making the collections, many duplicates have been collected, to these have been given the same numbers received by the specimens in the museum cases. It is the intention of the management to place these duplicates in suitable drawers in which they will be accessible and to make up sets for the use of the public schools, and to be used in exchanges.

Application has already been made by the State Normal Schools, and, as soon as possible, selections will be set aside from the duplicates for those institutions. Application was also made by the dental department of the State University for a set of minerals to illustrate hardness of minerals, which was furnished as requested.

The request is often made of the Mining Bureau to send such specimens of zinc, kaolin, tin, antimony, nickel, etc., to educate the eye of the prospector, and to compare with some suppositious mineral found; such requests are always complied with when possible.

While no great effort has been made to obtain them, many valuable works on mining and kindred subjects have been added to the library, mostly by donation; a few have been gained by purchase. This department is destined to become an important feature of the State Mining Bureau. A library of reference, free to all, embracing special works, not attainable elsewhere, will be a valuable aid to the community searching for information on these subjects. On another page will be found a statement of the books, pamphlets, maps, charts, etc., already collected.

Since the last report, the State Mineralogist has found time to visit several interesting mineral localities in the State, copious notes of which were made, but owing to lack of assistance it has been found impossible to prepare them for this report. In El Dorado County, the Alabaster Cave, situated on section nine, township eleven north, range nine east, was visited, near which is found a deposit of orbicular diorite (Napoleonite), found elsewhere only on the island of Corsica, France; the exact California locality is section seventeen, township eleven north, and range eight east. A fine specimen of this rare and beautiful stone may be seen in the State Museum, No. 1858. Roscoelite, found only at Granite Creek, El Dorado County, will be described elsewhere in this report.

At the Stockbridge Soapstone Quarry, Nevada County, a fire-proof material is found which has been substituted for fire-brick in the lime kilns with success. The granite quarries at Penryn and Rocklin were examined. Mr. Griffith Griffith, proprietor of the former, presented a fine vase of granite to the museum, which is entered in the catalogue No. 3364. This specimen not only represents the beautiful granite of that locality, but illustrates the skill of the mechanics and artisans of California. On Duncan Hill, Placer County, several quartz mines were examined, and information obtained of deposits of chromic iron at several localities, and of excellent roofing-slate near Georgetown.

In January, 1881, the mud volcanoes of the Colorado Desert were visited, an account of which will be found under the proper head.

The Clipper Gap iron mines were also visited, for the second time, when the furnaces were in full blast.

A special visit was made to Calaveras County, to examine a newly discovered cave, which contained a quantity of human bones. It was decided that these were not pre-historic, as a search in the bottom of the cave, after several days' work by employés of the Mining Bureau, failed to yield any evidences of an ancient race. It is singular, however, that the name of the county is the Spanish for a skull, and that Professor Blake, while engaged in the United States railroad survey, should have obtained a fragment of a human jaw, teeth, and a perforated shell, taken from a cave in Calaveras County. Some history may yet come to light which will explain the bones in the new cave.

Considerable work has been done on a catalogue of the minerals found in the State, which cannot be published in this report, already more voluminous than was at first intended.

A paper on chromic iron, and one on the borax interests and production of the Pacific Coast, are also in preparation, and a series of scrap books, for the compilation of newspaper scraps, have been commenced, in which articles are classified as follows: Mining Machinery, Geography, General Geology, Mineral Springs, Debris Question, and General State Interests.

It has been intimated that the Mining Bureau has paid undue attention to the collection of curiosities, and specimens of natural history, and, in doing so, has overstepped the intentions of the Mining Bureau bill. While it is true that many valuable donations of this character have been received, it is also true that, with a few trifling exceptions, no money has been expended, beyond furnishing cases and paying necessary freight; nor in any way has the legitimate working of the Mining Bureau been interfered with by this cause. The popularity of the institution has stimulated the generosity of citizens, and the State Museum has been greatly enriched by these donations. The policy of the State Mining Bureau was set forth in circulars issued and published in the first report of the State Mineralogist, from which no deviation has been made, except when forced by the diminishing Mining Bureau fund.

Correspondence has become an important department of the institution, and has increased until it demands a great deal of the time of the State Mineralogist. To facilitate the answering of letters the following circular was prepared:

[CIRCULAR.]

CALIFORNIA STATE MINING BUREAU,
OFFICE OF STATE MINERALOGIST, SAN FRANCISCO, ---------, 1880.

The Act creating the State Mining Bureau, for the advancement of legitimate mining in California, provides for the collection and display, in a State Museum, at San Francisco, of the varied mineral products of California—the collection to include not only the precious metals, but all minerals which have an economic value and can be used in the arts, in manufactures, in agriculture, or in commerce.

It is the province of the State Mining Bureau to give general information relating to the mineral interests of the State, to aid in which, correspondence is solicited. Information, however obtained, will be placed on record in the office of the Mining Bureau for the use and benefit of all interested. It will be the aim of the Bureau, through the agency of the State Museum and by its publications, to call the attention of the world to the natural advantages of California as a desirable place of residence, and as a field for the profitable investment of capital. To secure this end, the coöperation of all those who have the interest of the State at heart, is much to be desired. Information, therefore, bearing on the general interest of the commonwealth, will be thankfully received.

This circular is specially prepared to assist in answering certain questions frequently asked in letters received by the Mining Bureau, and to avoid constant repetition in replies. Information is frequently asked, that can be better given in a carefully prepared circular than by the pen.

The correspondence of the Bureau has increased to that extent that it is impossible to answer all letters in detail without some plan to save labor, and it is often impossible to answer immediately, for the following reasons:

First—All letters must take their turn.

Second—The information asked cannot always be obtained without delay, and specimens sent with letters do not in every case reach the Bureau at the same time. Frequently specimens require careful examination, in which they must take their turn.

Third—Sometimes the State Mineralogist is out of the city, and all specimens requiring his special attention must await his return.

For the above reasons, neither delay nor extreme brevity in correspondence should be taken for neglect.

Ores are frequently sent to the State Mining Bureau to be assayed for gold, silver, lead, copper, tin, etc. The Bureau does not make commercial assays, for the reason that such a course would interfere with the business of assayers, which was not the intention of the framers of the bill.

While the Mining Bureau cannot, for the above reasons, agree to furnish assays, it will determine minerals, and will make analyses of any new mineral discovery the publication of which would be of interest to the citizens of the State generally.

All iron ores, mineral waters, building stones, marbles, limestones, coal, coal oil, asphaltum, and other useful minerals, will be analyzed or examined, and the results published. This will be done for a double purpose—first, to give the world a reliable account of what the State produces; and to encourage others to search for valuable minerals. All information given by the Bureau, and all work done, will be free.

The State Mining Bureau does not take any interest in mining property, in the sense of negotiating sales or furnishing capital.

When specimens of valuable minerals are received, they are carefully labeled and placed in cases in the Museum, where they can be seen and examined by all. When inquiry is made for certain minerals found in the State, the persons making such inquiry are shown the case containing minerals of that class, and all information given.

The Mining Bureau does not deal in mining stocks, nor will it give any quotations or advice as to their purchase or sale, but will at all times give such information as it may possess concerning the mines themselves.

It is desired to make the ethnology of the Pacific Coast a feature of the Museum. All Indian relics, recent or pre-historic, will find a place, and their collection will no doubt throw much light on the ancient history of the State.

Every article sent to the Bureau will become the property of the State, for the use and benefit of the public, and will be carefully preserved in the State Museum.

All packages should be addressed to the California State Mining Bureau, San Francisco, and sent by Wells, Fargo & Co.'s express, or by railroad or steamship lines as slow freight.

HENRY G. HANKS,
State Mineralogist.

Under the proper heading will be found a statement of the number of letters received and sent, subjects, etc.

The work of the laboratory practically ceased with the suspension of the chemist, many determinations of minerals, however, have been made by the State Mineralogist, and a few analyses by Mr. Edward Booth, previous to the closing of the laboratory, among which the following are important:

Ore from Pioneer Copper Mine, Bolinas Bay, Marin County, California, consisting of quartz, erubescite, chalcopyrite, and malachite:

Assay.	Oz. per ton.	Value per ton.
Gold	Trace.	
Silver	5.6	$7 22
Total	5.6	$7 22

Copper, 10.11 per cent.

Supposed silver ore, Redwood City, California, assay showed that neither gold nor silver were present.

Analysis of a typical sample of "slickens," which appears under the head of placer and drift mining.

ANALYSIS OF WATER FROM ÆTNA SPRINGS, NAPA COUNTY, CALIFORNIA.

Characteristics.—Clear, colorless, a light film of oxide of iron, the only solid matter visible; odorless; taste, slightly alkaline; reaction, slightly alkaline; softness, very pronounced; specific gravity, 1.0023; solid constituents, 161.68 grains per imp. gallon, or 2310.37 parts in 1,000,000.

The following is the result of the analysis, being the chemical substances found and the weight of the same:

	Parts per 1,000,000.	Grains per gallon.
Chlorine	288.28	20.18
Sulphuric acid	34.70	2.43
Carbonic acid	826.31	57.84
Boracic acid	117.21	8.20
Calcium	35.43	2.47
Magnesium	80.67	5.64
Sodium	267.48	18.72
Potassium	558.81	39.11
Iron	3.08	.21
Silica	98.40	6.88
Phosphoric acid	Trace.	Trace.
Manganese	Trace.	Trace.
	2,310.37	161.68
Free carbonic acid	173.26	12.12

It is impossible to say how these elements and compounds are combined in the water, but, carrying out the rules which govern such calculations, the following results have been obtained:

	Parts in 1,000,000.	Grains per Imp. Gallon.
Borax	151.76	10.62
Carbonate of potassium	657.85	46.05
Carbonate of sodium	354.14	24.79
Carbonate of magnesium	282.76	19.79
Carbonate of calcium	57.16	4.00
Carbonate of iron (ferrous)	6.38	.45
Sulphate of sodium	6.86	.48
Sulphate of calcium	42.72	2.99
Chloride of potassium	355.95	24.92
Chloride of sodium	195.91	13.71
Silica	98.40	6.89
Phosphoric acid	Trace	Trace
Manganese (carbonate?)	Trace	Trace
Totals	2,209.89	154.69
Error due to theoretical grouping	100.48	6.99
Totals	2,310.37	161.68

Analysis of a sample of California refined borax, from San Bernardino, the production of the San Bernardino Borax Mining Company:

Borax	Water 47.05 Biborate of Sodium 52.80	99.85
Chloride of Sodium		Trace.
Sulphate of Sodium		Trace.
Insoluble residue		Trace.
Total		99.85

Analysis of a sample of concentrated borax, from Smith Brothers' Borax Works, Esmeralda County, Nevada, and of the insoluble residue which interferes with its crystallization:

Borax	Water 46.25 Biborate of Sodium 52.68	98.93
Chloride of Sodium		.50
Sulphate of Sodium		.25
Insoluble residue		.38
Total		100.06

The insoluble residue consists of—

Water	9.00
Organic matter	6.40
Silica	73.32
Sesquioxide of Iron	1.42
Lime	3.87
Soda	5.51
Total	99.52

Much was said on the occasion of the recent mineral exposition at Denver, as to the State being represented. The same controversy will arise from time to time, and it would be well to come to some understanding on this very important subject, and to decide if it is worth while to take advantage of such opportunities, to the credit of the State. If it is proper and politic to do so, some decided action should be taken in time, and appropriations made to carry out that end. This is clearly a matter which interests the whole State, and not only a few extra public-spirited citizens, who are generally called on for funds at the last moment and unfairly criticised if they fail to respond. This is a mild form of blackmail which is not worthy of our citizens. If it is considered proper to have the State represented at future world or domestic expositions, it is proper for the expense to be borne by the State, which is benefited as a whole. If this matter is considered in time, there would be no difficulty in making a creditable exhibit; but if left until the last moment, collections are made too hastily and sent forward in an unfinished condition. Yet, in the popular enthusiasm it is too often expected that energy will take the place of painstaking details, which can only effect the purpose.

It was thought by some, that the State Mineralogist should have acted officially on the occasion of the Denver Exposition. While he was willing to do so, he had no authority. The following decision by the Attorney-General of the State settles, for the future, the question as to the removal of the collections from the museum of the State Mining Bureau:

W. B. Ewer, Commissioner to Denver Exposition, San Francisco, California:

Dear Sir: After considering the contents of your letter of the third instant, and upon examining the "Act" to provide for the establishment and maintenance of a Mining Bureau, passed April 16, 1880, I am of opinion that the Governor has no control over the specimens and ores in the Mineralogical Bureau, and that, therefore, permission received from him to remove the specimens, for the purpose of placing them on exhibition at the Denver Exposition, would not add anything to the authority of the State Mineralogist.

The geological and mineralogical specimens which have been collected by or under the direction of the State Mineralogist are in his charge, and if he causes them to be removed from the State, he will be responsible for their safe return.

I regret that I am unable to find any statute authorizing the removal of these specimens. The State Mineralogist, being a statutory officer, has no authority in excess of that conferred upon him by the statute creating the office and prescribing his duties.

The benefits to the State from a proper exhibition of her minerals at the Denver Exposition would be so great that it will be a matter much to be regretted if we are not represented there.

I have the honor to remain your obedient servant,

A. L. HART, Attorney-General.

Sacramento, California, August 17, 1882.

There will be two important World's Fairs within the next five years—one at Amsterdam, in 1882, and the second at Rome, in 1887, for which the municipality of Rome has voted three million francs. If California is to be represented at either or both of these expositions, now is the time to begin to prepare for them.

Since the publication of the last report unmistakable evidence of increasing confidence in the mines of California has become manifest, and renewed attention is being called to the mineral interests of our own State, to a certain extent neglected during the speculative excitement, caused by the discovery of the Comstock and other mines in Nevada and neighboring States and Territories. Old districts, abandoned during that wild and disastrous excitement, are again coming into notice, and it is admitted that the statements of the early discoverers were not without foundation. Among these instances may be mentioned Bodie, Owens' Valley, Meadow Lake, the copper mines of Calaveras, Old Slate Range, Panamint, and others. Besides the old localities, many new districts have been brought to notice, which promise to add vast wealth to the State. An instance of the tenacity with which California miners cling to their claims, and the enduring faith with which they carry out their plans, based on theory or actual prospect, has been brought to the notice of the Bureau by Dr. William Jones, who vouches for the truth of the statements. Such instances are not uncommon in California, and argue well for the future mining prosperity of the State. The following is an extract from a letter to Dr. Jones, in reply to a request that the owners of the claim would give its history in writing:

GASCON HILL, Calaveras County, Cal., September 15, 1882.

* * We sunk a shaft, in 1859, about ninety feet deep. When we quit work, at night, we left the tools, in the bottom, perfectly dry; when we went in the morning, the water was within eighteen feet of the top. The tools are there yet. The flat is about 400 feet in width, by 500 yards in length. The surrounding ridge is about 100 feet in height. It is situated nearly one mile from Cave City, in a northwesterly direction from the cave. The shaft is about 300 feet from the mouth of the tunnel. I gave the tunnel a fall of about one inch to the foot. I expect to strike the shaft at a depth of sixty feet. As near as I can guess, the depth of the tunnel is about 150 feet below the highest point of the hill. The tunnel is seven feet high, and four feet in width, and about 500 feet long. We did not run the tunnel to strike the shaft. There was no rock but slate, granite and limestone. We commenced the tunnel in 1859, and turned the first water through in 1880. * * The cost of the tunnel was over $12,000. My brother went over the mountains, and worked steady, at good wages, for nine or ten years, and all his earnings were sent to me, to carry on the work in the tunnel.

In 1880 I used water four months, to get an opening on the claim, and, in 1881, I used water three months before I got into pay dirt; and then, arter a run of two months, I cleaned up eighty ounces. The Gascon Hill lead could be worked through the tunnel for one and one half miles. The gold is bright, washed gold, some very fine, and some coarse; I have got some pieces three and four ounces. The cement, when wet, is very tough, and rolls off in balls; when dry, it is like ashes. * * *

The unfortunate clashing between two of the great interests of the State has retarded certain branches of mining, and has no doubt prevented the investment of capital, but it cannot be doubted that these differences will, in the near future, be settled in equity and to the satisfaction of both parties, without paralyzing the mining interests, which have done so much for the State of California and the Federal Union.

Our citizens are awakening to the fact that we have within our own borders mining area sufficiently extensive and rich to give employment to all the capital and labor we have at our disposal for mining investment, to the benefit of a large portion of our population, directly or indirectly. When we come to regard mining as a legitimate business, and look to the mines themselves for returns on capital invested, it will be found that there is ample opportunity for the profitable employment both of capital and labor. The importance of legitimate mining as a source of wealth to the State and for the creation of capital cannot be too strongly expressed. No business requires more judgment, perseverance, industry and economy, or gives a more certain recompense for the exercise of these qualities.

When men embark in mining enterprises they should be governed by a well matured and settled plan which should be carried out with intelligence and integrity. Mines that pay from the commencement are exceptional. It will generally be necessary to invest capital before returns can be expected. This should be done with the understanding that it may be lost, but of course, with the reasonable expectation that valuable developments will be made, for no individual or company of men will commence work where there are not indications to warrant it. If the explorations are sufficiently encouraging, the work should be carried on. If a deposit of valuable ore is developed, preliminary shafts should be sunk and levels driven until a body of ore is isolated sufficiently large to justify an opinion as to the nature of the machinery required for its reduction, or to decide if the ores shall be taken out and sold. At this point some idea of the value of the mine may be gained. It must, however, be understood that every ton of ore extracted lessens the value of the mine. This fact must always be kept in view. If a large body of ore is uncovered in the mine, it may be thought best to erect reduction works. This is an important step and should be well considered. If the projected works require the investment of capital equal to the value of the ore in sight the question should be still more carefully considered, for if the ore body should give out below the line of exploration the machinery would be comparatively worthless. Such mistakes in California have been of too great frequency. It would be better, under these circumstances, to employ machinery on a corresponding scale, or to send the ore to a custom-mill, and to continue the exploration in the mine. If the body or bodies of ore are of sufficient magnitude and richness, and the process adopted be found satisfactory, the mine soon begins to pay, and the proceeds, after deducting expenses, are divided among the owners. This is legitimate mining. As a contrast, it may be shown, that speculative mining has been conducted in California in an entirely different manner, and to this class of adventure our State may attribute its recent adversity. Until this error is abated, even legitimate mining will be looked on with disfavor by those who do not understand it. The value of an unprospected mine cannot by any possibility be determined except by exploration. It does not follow that because other mines in a certain mineral district are rich, that one under consideration should also prove so, nor is the reverse to be assumed.

It is a great mistake to base the value of a mine on a single assay. There are abundant deposits of mineral matter in veins in which small quantities of extremely rich ore may be found. Too often these are carefully selected and brought to the assayer, who honestly gives his certificate of assay; the statement goes forth that the mines contain only such ore, and capitalists are asked to invest in them on this assumption. An assay only states what the ore would yield if it was all like the sample, which is seldom, if ever, the case.

A mine is worth what can be obtained from it, after all expenses are paid, and no more. The prospective value of a mine can only be estimated from what is in sight, in the different workings, which can be measured like a pile of brick, or the wheat in a warehouse. This view mine owners and prospectors are generally unwilling to take, and too much money has been lost and won without considering the actual value of the mine at all. When honestly or otherwise, the public can be made to believe that a mine is rich, the price of the stock goes up, and money changes from hand to hand, without the real value of the mine changing in the least. Mining can only be successful when regarded as a legitimate enterprise, the profits of which can be estimated like any other business.

In the first report of the State Mineralogist, mention was made of the great alkaline lakes of the State and their prospective importance. Samples of the waters of Mono Lake have been sent to the Mining Bureau, and an analysis commenced has been carried far enough to prove that the water contains large quantities of valuable salts, including borax. Owing to reasons before stated, it has been found impossible to finish these important analyses in time for this report. Samples from Owens, Goose, Honey, and other lakes, have also been sent to the Bureau, but it has been found impossible to do more than examine them in a general way.

All mineral waters should be carefully studied, and official analyses made and published by the State. It is too frequently the case that imperfect or inadequate analyses by unskilled persons are widely published, misleading physicians, and causing serious injury to the health of those who use them. In this connection much important data has been collected, some of the springs visited, samples taken, and a few analyses made, one of which appears in this report; others will be published in due time, should the plan of having a suitable laboratory, with assistants, be carried out.

The Mining Bureau is indebted to Wells, Fargo & Co., the Central Pacific Railroad, and the various steamship lines, for favors extended, and the State Mineralogist takes this occasion to express thanks for the same.

Citizens generally have shown a disposition to aid the State Mineralogist in collecting the various minerals, ores, etc., of the State, particular credit is due to Mr. Jacob Z. Davis, who has not only donated many costly and interesting specimens, but has spent much time in seeking objects of interest for the museum, and has otherwise assisted the State Mineralogist. In the report of the Secretary will be found a list of the names of donors to the museum and library, as far as catalogued. All others will receive due credit in future reports.

REPORT OF THE SECRETARY.

ADDITIONS TO THE MUSEUM AND LIBRARY.

The State Mining Bureau has accumulated during the twenty-one months since the last report, December 1, 1880, and until September 1, 1882, 724 books and pamphlets, 66 maps, charts and pictures, and 2,124 specimens of minerals, etc., as follows:

Donated—Books and pamphlets, 622; maps, charts, etc., 39; minerals, etc., 1,904; total, 2,565.
Purchased—Books, 102; maps, etc., 27; minerals, etc., 220; total, 349; grand total, 2,914.

This, added to the previous collection, which consisted of—

Books and pamphlets, 433; maps, charts, etc., 61; minerals, etc., 2,023; total; 2,517; presents a total of 5,431 catalogued and prepared for exhibition.

There is still a large number of mineral and other specimens, not yet catalogued, of which no record is made.

CORRESPONDENCE.

Since the date of the last report, 1,090 letters have been written to 1,023 correspondents, as follows: Communications and replies on sundry subjects, 566; acknowledgments, 198; information on minerals, 151; information, various, 175; total, 1,090.

During the same period there were received 900 letters from 659 correspondents, as follows: Sundry subjects, 186; acknowledgments, 91; inquiry on minerals, 96; inquiry, various, 206; donations, 98; information, 223; total, 900.

STATE MINING BUREAU.

Receipts and Expenditures from December 1, 1880, to September 1, 1882.

Expenditures.		*Receipts.*	
Postage	$91 50	State Treasurer—Bureau Fund	$13,915 00
Museum expenses	1,379 98	W. F. & Co.'s Bank—Advances	1,517 46
General expenses	8,886 83		
Maps	93 35		
Books	229 60		
Salaries	4,467 75		
Traveling expenses	283 45		
Total	$15,432 46	Total	$15,432 46

Average monthly expenditure, $734 88.

MEMORANDUM.

Income of State Mining Bureau.

1880.	*S. F. License Collector.*			*Warrants issued on Mining Bureau Fund from December, 1880, to June, 1882.*	
Oct. Nov. Dec.	Monthly average	$1,174 23	$3,522 70		
1881.				Salary of Mineralogist	$5,250 00
Jan. Feb. Mar.	Monthly average	996 33	2,989 00	General expenses	13,915 00
				Balance to credit of Mining Bureau	1,693 65
April May June	Monthly average	800 30	2,400 90		
July Aug. Sept.	Monthly average	1,203 63	3,610 90		
Oct. Nov. Dec.	Monthly average	790 83	2,372 50		
1882.					
Jan. Feb. Mar.	Monthly average	777 33	2,332 00		
April May June	Monthly average	644 90	1,934 70		
July Aug. Sept.	Monthly average	542 66	1,628 00		
	Other sources		67 95		
	Total		$20,858 65	Total	$20,858 65

LIST OF DONORS.

Abbott, Henry,
Acker, E. O. F.,
Aldrich, H. A.,
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Allen, C. F.,
Allen, W. D.,
Allen & Lewis,
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American Museum of N't. Hist.,
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Burrows, H. L.,
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Cal'a Portland Cement Co.,
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Collins, R. M.,
Collins, S. W.,
Colman, N. J.,
Connolly, F. F. A.,
Connor, S. P.,
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Cook, Prof. Geo. H.,
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Department of State U. S.,
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Faust, H. W.,
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Figel, Philip I.,
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Floyd, James G.,
Foote, A. E.,
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Foye Bros.,
Frank, C. J.,
Franklin, E.,
Frazer, C.,
Frenzel, E. A.,
Frost, J. S.,
Frost, S. W.,
Fuller, O.,
Fulton, R. L.,
Fulweiler, J. F.,
Gale, Mrs. S. A.,
Gallagher, Edward A. T.,
Gannon, Patrick,
Garden, J. W.,
Gardiner, Robt.,
Gardner, Rev. Frederick,
Gardner, Geo. W.,
George, Dr. S. G.,
Gerold & Weidenhofer,
Gladding, McBean & Co.,
Goldston, L. P.,
Goodwin, Chas.,
Gorley, Capt. H. A.,
Gove, A. W.,
Green, W. H.,
Griffith, Griffith,
Griffin, Thos.,
Grogan, Michael,
Gunn, B. M.,
Haas, A.,
Hague, Capt. C. J.,
Hailey, M.,
Hale, W. E.,
Haley, S. B.,
Hall, J. R.,
Hall, William,
Hall, Wm. Ham.,
Hamilton Reduction Works,
Hamlin, A. C.,
Hanks, Henry G.,
Harford, Wm. G. W.,
Harris, W. N.,
Harrison, B. A.,
Hart, A.,
Hartson, C.,
Hatch, A. J.,
Hatch, Dr. F. W.,
Hawes, Geo. W.,
Healey, Chas. T.,
Healey, Lieut. M. A.,
Hearn, Dr. F. G.,
Henderson, Geo.,
Heydenfeldt, Judge S.
Heydenfeldt, S., Jr.,
Hicks, J. K.,
Hoagland, Jas. A.,
Hoagland, Osborn & Co.,
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Hollis, Wm.,
Holliday, S. W.,
Holmes, H. T.,
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Holt, Mrs. J. H.,
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Hopkins, C. T.,
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Hueter Bros. & Co.,
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Hurley, Horace,
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Jenney, W. P.,
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Johnson & Bicknell,
Johnson, J. F.,
Johnson, Wm. Neeley,
Jones, Hon. J. P.,
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Journal of Commerce,
Julien, Alexis A.,
Kelly, G. P.,
Kelley, Jay G.
Kelly, Wm. H.
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Kinney, Dr. Aug. C.,
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Knox & Osborn,
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Lane, J. H. M.,
Larson, Andrew,
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LeDuc, Wm. G.,
Lee, Bruce S.,
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Love, Miss Lilly,
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Wilkinson, J. W.,
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Winans, J. C.,
Winder, W. A.,
Woodhull, S. D.,
Woodward, E. W.,
Woodward, R. B.,
Woolverton, J. R.,
Wright, Alfred,
Yale, Chas. G.,
Zuber, G. L.,

The following is self-explanatory:

License Collector's Office, San Francisco, October 2, 1882.

Henry G. Hanks, Esq., State Mineralogist:

Dear Sir: Understanding that you are preparing your semi-annual report, to be presented to the incoming legislature, if agreeable to you, I will make a few suggestions, with a view to improving the law for the collection of the stock certificate tax.

Section 2 of the Act reads as follows:

"It shall be the duty of the Secretary of every such corporation, on the first Monday in January, April, July, and October of each year to make return under oath to the Tax Collector, or the officer acting as Tax Collector, of the number of certificates issued by the corporation for which he is Secretary during the preceding quarter, and pay to such Tax Collector the sum of ten cents in coin for each and every certificate so issued." You will observe by the reading of this section just quoted that if there be no issue of stock the Secretary is not compelled to make a return. I have good reason to believe that it costs some of them very little trouble to come to the conclusion that none were issued for the preceding quarter. I find that secretaries who are permanently located make regular quarterly returns, but in a large number of cases one person acts as Secretary for a number of corporations, and in many cases carry their offices in their respective hats.

No matter how zealous an officer may be in the discharge of his duty, some of the latter class will evade the payment of the tax, while the more scrupulous and responsible ones have to pay. To remedy this I would suggest that the law be amended so that the Controller or Secretary of State be authorized to issue stamps to the collectors in the several counties of the State, charging each one with the number furnished him. The collectors, to make quarterly returns as now, require the secretaries of corporations to procure these stamps from the Collector in their respective localities. Make the law read that a certificate of stock will be of no legal value unless one of these stamps are upon it. I would further suggest that there should be two classes of stamps, one for original issue of certificates, and another for transfer of stock certificates.

Under the present law there is no check upon the accounts of the collectors with the State, but under the system above suggested there would be a perfect check. In addition to that the burden of taxation would bear equally on all those who are engaged in this line of business, besides it would do away with a large expense for books, stationery, etc., which is now made necessary under the present system.

Very respectfully, D. R. McNEILL.

RECEIPTS OF MINERALS AND MINERAL PRODUCTS AT SAN FRANCISCO,

From June, 1880, to June, 1882, Inclusive, Compiled from Files of the San Francisco Newspapers.

Salt—In tons.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880—From Bay						320	530	986	800	942	1,070	1,160	5,808
1880—From Carmen Island						260			250	630			1,140
1881—From Bay	795	796	480	1,105	1,060	1,620	1,065	1,364	1,060	1,673	1,762	730	13,510
1881—From Carmen Island						1,225							1,225
1882—From Bay	397	625	895	1,659	1,665	1,520							6,761
1882—From Carmen Island				340									340
Grand total													28,784

Lime—In barrels.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880						318	149	219	165	207	188	296	1,542
1881	7,834	3,725	7,535	13,699	15,841	10,234	10,519	10,933	12,598	13,710	12,754	10,197	129,579
1882	8,136	7,047	8,302	12,353	17,176	14,517							67,531
Grand total													198,652

Borax—In centals.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880						2,591	2,887	5,900	2,058	2,462	2,423	3,235	21,756
1881	4,245	1,624	2,440	3,059	3,312	4,256	3,174	1,861	3,001	3,738	2,367	3,208	36,285
1882	2,570	1,703	2,550	2,861	2,660	818							13,162
Grand total													71,203

Soda.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880—Centals						919	2,230	1,041	390	1,910	759	492	7,741
1881—Centals	1,069		210		407	309	195	597	1,001	652	276		4,716
1881—Sacks		40	120	80	60	80	90	40				18	528
1882—Centals	244	511		264	503	611							2,133

Chrome Iron.													
1880—Tons						1,020	753½						1,773½
1881—Tons								453	175		140		768
1881—Centals					2,243							875	3,118
1882—Tons			393	385	441½	130							1,349½
1882—Centals		13,332		5,467									18,799
1882—Barrels			55										55
Antimony.													
1880—Tons													
1880—Centals						278			750	455	261	1,855	3,599
1881—Tons		100			125	190			260	450			1,125
1881—Centals	520	547	212	864	1,172	279					608	408	4,610
1882—Tons	150												150
1882—Centals			946	206	300								1,452
Asphaltum.													
1880—Tons						150	37	16	2	148	75	229	657
1880—Sacks						94							94
1881—Tons	40	45	217			55	175	75	50		75	115	847
1881—Sacks			5	179	207	431	50	295	661	630		299	2,757
1882—Tons			14	292		211							517
1882—Sacks	71			49									120
Lead—In centals.													
1880						9,051	2,090	6,270	11,165	4,626	24,699	9,599	67,500
1881	11,219	2,154	6,747	4,290	13,395	11,481	6,716	1,496	1,998	14,765	16,076	14,790	105,127
1882	5,332	4,349	1,517	1,324	6,938	7,331							26,791
Grand total													199,418

RECEIPTS OF MINERALS AND MINERAL PRODUCTS—Continued.

Unspecified Ores.

YEARS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1880—Centals						1,150	2,812	13,710	8,880	200	182	4	26,938
1881—Centals	657	222	1,053	408	1,050	522		192	20	331	778	543	5,776
1882—Centals		212	547	424	451	783							2,417
Grand total in centals													35,131
1880—Sacks									14	12	15		41
1881—Sacks	5		15	15	3		1	6	29	52	30	9	165
1882—Sacks				11	2	59							72
Grand total in sacks													278

Iron.

YEARS.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1880—California—In centals													
1881—California—In centals					1,465	5,844	1,882	1,583	3,367	6,495	6,561	3,022	30,219
1882—California—In centals	5,269	7,604	2,781	1,831	2,341	223							20,049
Grand total from California, in centals													50,268
1880—Oregon—In tons						308½	187¼	391	380¾	393½	416½	597½	2,674¾
1881—Oregon—In tons	334½	322	399¾	327¾	273	228½	275¼	257½	30	127	282¾	232	3,090
1882—Oregon—In tons	210½	107	181½	206	156	396½							1,257½
Grand total from Oregon, in tons													7,022¼
1880—Irondale—In tons													
1881—Irondale—In tons					100	359				112½	246		817½
1882—Irondale—In tons				76									76
Grand total from Irondale, in tons													893½
1882—Port Townsend—In tons				5									5

Sulphur—In centals.

1880	-------	-------	-------	-------	-------	3,322	1,557	675	210	979	934	1,448	9,125
1881	525	1,407	1,215	863	1,428	1,182	2,327	692	718	223	378	246	11,204
1882	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	400	-------	400
Grand total	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	20,729

Base Bullion—In centals.

1880	-------	-------	-------	-------	-------	9,975	-------	-------	212	-------	2,438	6,777	19,402
1881	2,455	4,750	4,759	4,971	1,599	889	1,019	2,063	300	-------	-------	-------	22,805
1882	-------	948	570	216	993	281	-------	-------	-------	-------	-------	-------	3,008
Grand total	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	45,215

Copper—In centals.

1880—Bullion	-------	-------	-------	-------	-------	-------	1,006	603	2,414	1,880	4,292	6,268	16,463
1881—Bullion	5,073	4,373	5,037	5,022	10,502	7,632	11,431	5,868	11,001	10,045	12,054	8,173	96,211
1882—Bullion	11,256	5,299	8,583	11,881	8,532	13,668	-------	-------	-------	-------	-------	-------	59,219
Grand total	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	171,893
1880—Cement	-------	-------	-------	-------	-------	-------	843	-------	59	-------	293	258	1,453
1881—Cement	555	-------	482	396	-------	-------	-------	242	-------	629	183	-------	2,487
1882—Cement	202	53	346	348	75	533	-------	-------	-------	-------	-------	-------	1,557
Grand total	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	5,497
1880—Ore	-------	-------	-------	-------	-------	3,571	4,579	4,178	7,034	3,599	7,345	667	30,973
1881—Ore	848	248	879	277	4,888	2,521	1,507	1,082	799	623	3,444	-------	17,116
1882—Ore	88	3,369	525	132	2,218	1,662	-------	-------	-------	-------	-------	-------	7,994
Grand total	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	56,083
1880—Mexican ore	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
1881—Mexican ore	-------	2,549	-------	-------	-------	5,433	214	-------	-------	-------	-------	-------	8,196
1882—Mexican ore	700	820	-------	-------	22	-------	-------	-------	-------	-------	-------	-------	1,542
Grand total	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	9,738

RECEIPTS OF MINERALS AND MINERAL PRODUCTS—Continued.

Granite—In tons.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880						318	149	219	165	207	188	296	1,542
1881	299	245	682	636	421	526	195	83	176	266	548	486	4,563
1882	158	652	313	225	437	517							2,302
Grand total													8,407

Quicksilver—In flasks.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880						5,868	4,985	2,419	3,461	5,287	7,202	4,219	33,441
1881	4,711	3,723	4,316	3,855	6,185	6,236	4,084	4,060	3,956	4,034	2,309	4,856	52,325
1882	3,755	2,625	2,947	3,562	3,616	4,971							21,476
Grand total													107,242

Silver Ore—In Centals.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880—Concentrations							1,069		380	2,162	2,231	2,382	8,224
1880—Ores						1,093	663	35	651		866	714	4,022
1880—Mexican ores						127	54	18	148	89		244	680
1881—Concentrations	1,258						99						1,357
1881—Ores	304	628	172	31		710	910	135	822	652	284	478	5,126
1881—Mexican ores	259	348	554	28	418	38	83	1	298	48	52	19	2,146
1882—Concentrations			215										215
1882—Ores	798	742	231	1,086	229	1,128							4,214
1882—Mexican ores	31	110		51	25	142							359
Grand total													26,343

Pacific Coast Coal—In tons.

1880—From Departure Bay						9,608	11,647	5,425	12,180	9,209	8,770	5,930	62,769
1880—From Coos Bay						2,672	3,050	3,535	760	1,655	3.931	2,201	17,874
1880—From Seattle						8,925	7,054	13,276	11,027	12,192	7,675	10,593	70,742
1880—From Nanaimo						6,230	4,185	4,856	3,985	10,060	5,065	3,000	37,381
1880—From New Tacoma													
1880—From Victoria						1,495		2,720			1,740	730	6,685
1880—From Rocky Mountains										10			10
1880—From Portland, Oregon												150	150
1880—From Mount Diablo						8,528	7,668	7,610	8,757	9,281	8,140	7,675	57,650
Grand total for seven months in 1880													253,261
1881—From Departure Bay	13,524	11,813	9,595	8,045	16,743	3,700	5,320	5,688	8,930	6,670	9,870	8,607	108,505
1881—From Coos Bay	4,448	3,790	1,150	2,521	5,188	1,130	500	1,570	1,050	4,000	1,517	1,050	27,914
1881—From Seattle	16,103	8,739	11,136	10,400	11,823	5,192	18,555	11,818	10,008	7,081	12,289	16,824	139,968
1881—From Nanaimo	1,530	4,150	714	4,439	3,420	7,448	1,750	7,550	3,478	1,568	3,065	1,080	40,192
1881—From New Tacoma	1,470	650	1,536	3,594	1,530	2,578	196	2,293	1,310			2,248	17,405
1881—From Victoria	400										1,580		1,980
1881—From Rocky Mountains	10												10
1881—From Portland, Oregon													
1881—From Mount Diablo	11,795	9,125	8,721	7,699	8,048	8,528	7,668	7,612	8,757	9,287	8,140	7,675	103,055
1881—From Esquimault						1,200							1,200
Grand total for 1881													440,229
1882—From Departure Bay	13,165	5,510	7,728	6,544	9,170	12,363							54,480
1882—From Coos Bay	2,180	525	1,575	1,050	1,244	1,050							7,624
1882—From Seattle	21,085	6,500	17,465	12,174	15,187	13,760							86,171
1882—From Nanaimo	3,054	4,976	3,250	3,505	1,645	2,235							18,665
1882—From New Tacoma	2,967	1,522	5,771	5,900	6,346	6,650							29,156
1882—From Sitka					858								858
1882—From Victoria						400							400
Grand total for six months in 1882													197,354

Receipts of Minerals and Mineral Products—Continued.

Petroleum.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1880—Crude—Cars										1	2	1	4
1880—Crude—Tank						17	14	11	12	7	25		86
1880—Crude—Barrels						190	10		102	145	212	224	883
1880—Refined—Cars						13	3	4	12	29	11	8	80
1880—Refined—Barrels							56	120			10	25	211
1880—Refined—Cases									750	751	75	781	2,357
1881—Crude—Cars	1	3					4	2	4	2	2	53	23
1881—Crude—Tanks		8	39	58	59	41	26	21	146	122	294	196	1,007
1881—Crude—Barrels	76	188	154	144	400	351	295	501	309	96	153	10	2,677
1881—Refined—Cars	10	17	14	11	9	7	3		4	6	12	10	103
1881—Refined—Barrels		25	5	250	119		50	70	18	59	162	65	823
1881—Refined—Cases			2,025	500	35	2,000	300		530	2,230	1,190	800	9,610
1881—Refined—Tanks					15								15
1882—Crude—Cars	6	7	11	13	11	14							62
1882—Crude—Tanks	340	58	34	43	86	81							642
1882—Crude—Barrels	187	92		75	38	202							594
1882—Crude—Cases				250									250
1882—Refined—Cars	9	8	8	10	2	6							43
1882—Refined—Barrels	70	100	135	115	50	124							594
1882—Refined—Cases	558	1,070	1,537	3,441	604	2,226							9,436

Estimated average of California production of Petroleum for 1882.

Los Angeles County—daily yield about	300 gallons.
Ventura County—daily yield about	150 gallons.
Santa Clara and Santa Cruz Counties—daily yield about	50 gallons.
Total daily yield	500 gallons.

Benzine.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1880—Cars									1	1		2	4
1881—Cars			2		1	3	4	1	1	1	1	1	15
1881—Cases			5									600	605
1882—Cars	4	2	4		3	1							14
1882—Cases	125		306	600	17	300							1,348

Gasoline.

Years.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1880—Cars										1		1	2
1881—Cars			1							1	1		3
1881—Tanks			7										7
1881—Barrels												42	42
1882—Cars		4	3		11	1							19
1882—Barrels	33												33

PLACER, HYDRAULIC, AND DRIFT MINING.

GENERAL REMARKS.

Placer mining is the gathering, by mechanical means, of native or free gold found disseminated in alluvial deposits in certain parts of the earth's crust. A placer being the gravelly bed in which such gold exists, the transition from primitive gold digging to hydraulic mining, which is placer mining on a gigantic scale, has been the result of experience, and the increasing difficulty of collecting gold after the more accessible deposits were exhausted.

In the early history of virgin gold fields, a certain proportion of the precious metal has been collected without great effort or skill, and with the most simple appliances. Every variety of placer mining is based upon the fact that gold has a greater specific gravity than most other metals or substances. This property causes it to resist the force of water in motion, which, acting upon other lighter minerals, moves them forward in the direction of the course of the stream, while the gold remains behind, and taking advantage of the agitation of movable particles, caused by the action of the water, gravitates toward the earth's center until arrested by the fixed rock formation, technically known to the miners as "bedrock." It frequently happens that the bedrock of a mountain torrent upon which the gold settles is smooth, and having a descent toward the plains below, the gold is forced forward by the stream, aided by the moving bowlders, until it meets some accidental depression, where it remains. Similar conditions cause other gold particles to move to the same depression, where in time a considerable quantity collects, and a natural placer is formed. In the early history of California, such depressions were sought in the beds of modern rivers, and large quantities of gold taken out. When the laws which govern these deposits were still but vaguely understood, the miner could without difficulty pan out almost fabulous quantities of gold dust. These placers were successively discovered and exhausted, after which gold washing became more and more difficult, and costly operations were then undertaken. Beds of swift-running rivers were exposed by turning the waters aside in artificial channels or flumes. Soon other appliances were required and invented to facilitate the collection of the gold from the placers, the cream of which had been skimmed by the lucky ones first on the ground.

The successive steps in placer mining, from the discovery of gold to the present time, have been as follows: The Miner's Pan, the Cradle, the Long Tom, the Riffle Box or Sluice, the Ground Sluice, Booming or Gouging, and Hydraulic Mining, which from a crude and insignificant begining, by progressive stages, has attained its present magnitude and importance.

That hydraulic mining may be thoroughly understood, the successive steps mentioned above will be described in detail.

MINER'S PAN.

The miner's pan is made of the best quality of Russia iron, some of them are stamped out of a single sheet, while others are jointed like the sections of a stovepipe; no solder is used as it would soon be taken up by the quicksilver frequently used. The miner's pan is, in form, something like the common milk pan, but with the sides more flaring. The usual dimensions are ten inches in diameter at the bottom, sixteen inches at the top, and two and two tenths inches deep. The angle of the sides from the horizontal is thirty-seven degrees. The rim is strengthened by a strong iron wire rolled in. This is the conventional miner's pan, and is the result of thirty-three year's experience in California. The retail price of such a pan, in San Francisco, is ninety cents.

The mode of using the pan, in placer mining, is as follows: Having carefully removed the superficial earth to a point within a few inches of the bedrock, the miner places a portion of the gravelly matter containing gold, in his pan, and goes to a neighboring stream, or pond, and kneeling by the side of the water, sinks the pan containing the auriferous earth slowly beneath the surface, holding it horizontally, and causing the water to flow into the pan equally over the sides; when the pan is full, he lifts it and placing it on his knee or on a convenient stone, he stirs the mass with his fingers.

The skillful miner, in washing a panful of dirt, unconsciously divides the operation into five stages. He breaks the lumps with his fingers and stirs the contents of the pan until a soft mud is formed. Sinking, now, the pan beneath the water, the second stage commences. This is to so agitate the muddy prospect that gold, gravel and coarse sand sink to the bottom, while the finer and lighter particles flow over the rim and escape. This being for a time continued, the remaining contents of the pan become clean and the water is no longer loaded with slickens. The third operation is to pick out carefully all the large pebbles and gravel which are examined, and if found worthless, are thrown aside. The agitation is continued with but little water in the pan, and by a motion of the ball of the thumb, difficult to describe, the coarse particles are raked out and rejected. At this stage a very large proportion of the original prospect has been removed, but every grain of gold lies at the bottom, although still invisible. The fourth operation is to so agitate the remaining contents of the pan (now inclined and only partly under the water) that the coarse sand flows over the edge in a thin stream, every particle passing under the eye of the operator, who may be certain that no gold escapes. This is continued until but a small quantity remains in the pan, when, lifting it from the water, the last operation begins, which is the concentration and perfect separation of the gold. This is effected by an undulatory motion, causing the sand to flow with the water across the bottom of the pan, revealing a cluster of gold particles, if the dirt is rich, and wholly isolated. The pan is then inclined toward the sand, leaving the gold stranded in one portion, and the sand and water lying in another. The edge containing the sand is then held over and very near the water, of which the miner lifts a small quantity in the hollow of his hand, and pouring it behind the sand, washes it away, leaving the gold only in the pan. There being no quicksilver used, the gold is collected wholly by its specific gravity.

It usually is found that a small portion of black sand appears beneath the lighter colored residue which results from the disintegration of igneous rocks, which does not necessarily indicate the presence of gold, although if gold is found at all it is generally associated with black sand, as they possess similar specific gravities. The gold may be dried in the pan and brushed out into some convenient receptacle. The last portion of black sand is taken out with a magnet, and the quartz sand gently blown away while the gold lies on a clean piece of paper, or in a peculiar flat scoop of tin plate or brass, made for that purpose.

From this "prospect" the gold washer judges of the value of the claim. Each particle of gold, no matter how small, is called a "color." To find the color is to find at least one particle of gold. From the quantity he will estimate, in a rough way, the value of the gold. He will state, with considerable accuracy, that there are "five cents to the pan," or "one dollar to the pan," as the case may be. Sometimes a large piece of gold will be found; but such a circumstance is quite unusual. The gold washer's pan, in the last stages of the operation described, often contains substances of great interest to the mineralogist; as, for example, beautiful zircons, platinum, unique crystals or scales of gold, occasionally rubies, and even diamonds, too minute however to have any but a scientific value, rolled masses of chromic iron, etc.

The miner's pan has become, in California, a sort of *vade mecum*, not only to the miner, but to the mill-man and the assayer. The same results are obtained in other countries by different appliances. The Cornish miner tests the quality of his tin ores by washing on the blade of a shovel; the Mexican uses a horn spoon, and the Brazilian the batea. The horn spoon is a long, irregular trough cut from a large ox horn. It is divided from the horn by sawing; when first cut is rough and clumsy, but by scraping it is soon reduced to an elegant and convenient vessel, admirably suited for washing small quantities, but too small for utility in placer mining, and open to the objection that it soon warps out of shape, and under the influence of repeated wetting and drying, cracks and becomes worthless. While the horn spoon is inferior to the miner's pan, the Brazilian batea is superior, and should be better understood by miners generally. The following extracts from a paper by Mr. Melville Attwood, of San Francisco, read before the California State Geological Society, set forth its advantages and describe its use:

Batea is the name given to the gold-washer's bowl, or vanning dish, used in the placer and gold mines of Brazil; a small implement, which affords the most simple method of separating, on a limited scale, the grains of gold from the dirt, sand, pyritic matter, magnetic iron, etc. The form of the batea in common use in Brazil is a circular, shallow, wooden dish, or bowl, rudely fashioned with an adze and chisel, varying considerably in depth and size, but, nevertheless, in practical hands giving remarkable results.

In 1853 I had a few bateas made of a much better form, the inside being turned smooth to the center, in a lathe. I introduced them at that time into the mills under my control at Grass Valley and Agua Fria, where they were used for the purpose of testing or making mechanical assays of the tailings, blanket-washings, and as a concentration to find the percentage of pyritic matter in the vein-stone under treatment.

Some years ago numerous samples of sea beach, or gold sands, were sent to me for examination, and as the batea I had then in use did not separate the gold particles as clean and rapidly as I wished, induced me to make further alterations. After many trials and much trouble, I succeeded in getting the form I now use. Those persons accustomed to use the horn spoon, or pan, would be astonished at the ease and rapidity with which the gold in the sands can be washed out with this improved form of batea. As a concentrator for small parcels, or to test the working of a larger one, nothing that I have yet seen in operation can equal it.

To test the value of gold quartz, Mr. Phillips, in his "Metallurgy of Gold and Silver," says: "The most accurate results are obtained by carefully washing a four-pound sample in the batea. After having in this way concentrated the gold in about an ounce of sand and pyrites, this residue may be either subjected to assay, or the sulphides dissolved by nitric acid and the gold extracted by amalgamation with a little mercury, which is subsequently volatilized and the gold weighed. In either case the calculations are made on the four-pound sample, and when the residue has been subjected to fusion, very accurate results are obtained."

It is very difficult to give written directions that can be followed for the use of it, but a few lessons from those accustomed to its use will enable any one to become a proficient in a very short time. I will, however, quote the directions given by Professor W. W. Smyth on the use of the old form, and that of Mr. Henry G. Hanks, more recently, in his valuable paper on "Quicksilver," published in the Alta California:

"A quantity of the material to be operated on having been mingled and well stirred by hand with water in the bowl, it is shaken from side to side and circularly, with a variety of movements suited to the form and to the nature of the ore, only to be acquired by long practice. The settlement and separation of the gold is partly assisted, also, by striking one side of the bowl occasionally, so as to arrest the course of the particles for the moment; and, finally, several different layers or lines of mineral matter may be distinguished from one another, the gold occupying the lower position, then the magnetic iron, then the pyrites, and, lastly, other wastes."

Mr. Hanks says:

"The manner of using the batea may be described as follows: Quite a quantity of water will be required. This may be contained in a tank or large tub, or may be a convenient place near the bank of a stream or lake. The pulverized ore—several pounds at a time—is placed in the batea, which is gradually sunk in the water. Several times it is broken down with the fingers, while the batea floats on the water. When the ore is thoroughly wet and formed into mud, the batea is taken by the rim with both hands and again sunk in the water. A circular motion is then imparted to it (soon learned by practice). The lighter particles will continuously flow over the edge and sink, while the heavier ones collect at the center.

"When only a small portion remains, the batea may be lifted, and the water held in the depression caused to sweep round the center, while one edge is slightly depressed. This motion will gradually remove the heavier particles toward the depressed part. If there is any gold, platinum, galena, cinnabar, or other unusually heavy substance, their gravity will resist the power of the water, while comparatively light particles move slowly forward. The form of the vessel is such that the heaviest matter forms the point of a sector, and can be closely observed. If there is a particle of cinnabar present, it will be found at the point, clearly distinct from all other substances. The value of the batea to the prospector cannot be too highly estimated, and it should come into more general use."

Mr. John Roach, of San Francisco, has used the batea for some time to assist him in some of his metallurgical investigations. He very kindly gave me the following directions, by which, he says, any good turner will be able to make them: "A disk of seventeen inches diameter being turned conical twelve degrees, will have a depth of one and seven eighths inches from center to surface. The thickness may be five eighths of an inch. The other edge, perpendicular to axis, will require wood two and one half inches thick for its construction. The best wood, Honduras mahogany."

To millmen it is a most useful instrument, enabling them, amongst other things, to test what quicksilver is being carried away in the tailings. Silver ore can easily be separated from its gangues. The lithologist it will help greatly in his examination of the basaltic and metamorphic rocks.

The movements of most of the large concentrators can be easily copied, particularly that of the percussion table, but with the difference in favor of the batea, that the shock, either light or hard, can be given and varied as required, by striking the side of the bowl with the hand.

MINER'S CRADLE.

The miner's cradle somewhat resembles the old fashioned child's cradle. It is mounted on similar rockers, and the motion is imparted in the same manner as a mother rocks her child. The machine is about four feet long and two feet wide; the whole apparatus has an inclination, and the lower end is open to allow the water and tailings free outlet. At the upper end there is a box, or hopper, the bottom of which is made of sheetiron, punched with holes half an inch in diameter. The box is movable, and is so constructed that it can be easily removed and replaced. Under the hopper there is an apron of canvass, inclining toward the head of the cradle at an angle of thirty degrees from the horizontal, but touching neither the floor nor upper wall. On the floor of the cradle there are nailed two riffle bars, each about an inch high, one near the lower end, and the other near the middle; these are transverse and at right angles to the course of the water which passes through the machine. When in use, the rocker is placed near a convenient water supply, which need not be large. The ground immediately under the machine must be level and hard. The miner sits or kneels near the machine, rocking with one hand, and while dipping and pouring water with the other, another man, generally his partner, brings the carefully selected pay dirt in a pan and dumps it into the hopper. The rocking and water pouring being continued, the finer portions and the free gold pass through the holes, and being diverted by the canvas apron, are thrown, with the water, to the extreme upper part of the floor, to flow downward and escape at the lower end of the rocking floor; the gold, with the heavy black iron sand, is arrested by the riffles. All stones and pebbles remain on the perforated iron plate, from which the larger ones are, from time to time, picked out and thrown aside. When smaller ones accumulate in such quantity as to become inconvenient, they are well washed in the hopper with water, examined carefully to see if, by chance, there might be any gold nuggets among them, when the hopper-box is lifted from its place, and by a quick jerk, the pebbles are thrown out and the hopper replaced. When it is required to clean up, generally at the close of the day, the hopper is removed and clean water poured upon the apron until it is thoroughly freed from any gold that might adhere to it; the frame upon which the canvas is nailed is then removed and the cradle set up on end, the floor washed into a miner's pan, and the gold collected in the manner already described.

The rocking of the cradle not only mixes the contents of the hopper, but keeps the sandy deposit on the lower floor in constant motion, causing the gold to settle behind the riffles, while the lighter particles flow over, pushed forward by the rushing water. When the stuff taken from the claim is unusually rich, a partial clean-up may be made several times a day, but the final washing in the pan invariably takes place at the close of day. It is sometimes found to be an advantage, when the gold is very finely divided, to place the hopper over the lower part of the machine, and to extend an apron, made of thick woolen cloth, or a piece of a good blanket, the whole length of the cradle, in which case a considerable portion of gold is frequently found in the nap of the cloth.

No rule can be given as to the inclination of the machine, which must be arrived at by a series of experiments. It will be found that the angle required is governed by the condition, not only of the gold, but also by that of the earthy matter in which it occurs. It is possible, but not convenient for one man to work the rocker unassisted. This is seldom practiced, except in case a miner has a rich claim, and wishes to keep his gains a secret from others.

The cradle is not an economical apparatus, as, from its rude construction, much of the free gold is lost, which is proved from the fact that some of the earlier placers have been worked over a number of times with almost equal success. It was, however, the best mode easily attainable in early times. It is now generally discarded by the white miners, but still used by the Chinese. The idea of the rocker is not new, but has been in use for hundreds of years, and may be considered as a re-invention called into use by similar conditions.

THE LONG TOM.

The "long tom" quickly took the place of the rocker, and for a time seemed to be an economical, effective and convenient method of saving gold, and to fill all the requirements of placer mining, but now it is never seen in use in California, having given way to the sluice box, yet to be described. The "long tom" was a rough wooden box or trough, from twelve to fourteen feet long, two feet wide at the upper part and widening to three feet at the lower end. The bottom was covered with sheet iron, in sheets laid like shingles, the edges overlapping. The sides of the tom rose at right angles with the bottom, and were about ten inches high. The lower end was terminated by a sheet iron screen, or riddle, with punched holes like the bottom of the cradle hopper. The transverse edge of the screen was turned up at a small angle. This apparatus was placed on some convenient support, inclined at an angle of from six to ten degrees, the perforated screen projecting over a riffle box extending in the same direction and at the same angle of inclination. Across the bottom of the box were nailed six or more cleats, like those described when writing of the cradle. The principles, use, method of cleaning up, etc., were the same as those pertaining to the rocker, but on a larger scale. The water was brought from a convenient stream, and received in a constant flow at the upper end. The rich dirt was thrown in from the sides by several men, by whom it was kept well stirred, while the larger stones were thrown out with an iron fork, made like a common manure fork, but with stronger and wider tines.

THE SLUICE BOX.

The next progressive step was to the sluice box; the great advantage of this method being that the sluice can be extended indefinitely, and that by subjecting the rich dirt for a longer time to the action of water, it becomes more fully disintegrated, and the gold set free. The increased riffle capacity admits of the arrest of more gold; that portion which escapes the first, settles in those below. A large proportion of the gold taken from the California placers has been won by the aid of the sluice box, and the experience made in them has led to their use, in an improved form, in quartz milling and hydraulic mining.

The sluice box is made in sections of twelve feet in length, which vary in width from one to two feet. The height is generally ten inches; the sections are made of three boards nailed together, forming the bottom and the two sides, both ends being open; one end is a little wider than the other to admit of the sections being slipped together like the joints of a stove pipe. A trestle-work support is generally built, having the required inclination, upon which the sections are laid, the end of each section slipping into the next one below and lapping from four to ten inches. Sometimes, for convenience, the sections are laid from one pile of stones or earth to another. The sluice is extended as far as, in the judgment of the miner, is required; the water is brought to the head, and movable riffles are properly placed, when the work of shoveling commences. To prevent the rich pay dirt from being thrown beyond the sluice, a short, but wide board is nailed, inclining a little inward, to the side

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opposite the position of each shoveler; the dirt striking against this shield must fall into the sluice. A number of men may work at the sluice, the number being limited by the supply of water and the character of the dirt, which must only be fed in as fast as it can be perfectly disintegrated by the water, assisted by constant stirring. The bowlders are thrown out with a sluice fork, which is similar to that described when treating of the long tom. The inclination or grade given to the sluice is generally six inches to each section of twelve feet, but some miners give them a greater grade. The riffles are made in sections of four feet in length, and are laid on the floor of the sluice, wholly covering it. An occasional cleat is nailed across the bottom of the sluice to prevent their slipping, or they are fastened by driving a few wedges.

The riffles are in effect wooden gratings made of bars from one to four inches square, and four feet long, placed longitudinally, and held in place by two or three cross pieces which are halved together so that the cross piece extends down to the bottom, and form a cross bar which arrests the gold and its heavy associates, which would otherwise pass down the tube-like openings and be lost. After the dirt has been running for some time, a little quicksilver is poured into the openings at the lower part of the riffles, and a larger quantity at the head of the sluice, which meeting the gold, arrests it and materially assists in its collection. In some sluice boxes amalgamated copper plates are used, but this is rather uncommon. It is not necessary to clean up very often, this is generally done every week, Sunday being usually selected as clean-up day. The day's work is generally ten hours, but in some cases the work goes on continuously for the whole twenty-four hours. When not at work it is necessary to carefully guard the sluice boxes, as sluice robbing is very common, and the robbers are exceedingly expert in the art. The most ingenious method being to take a silver spoon and after dipping the bowl into the mercury to stir and dip up the stuff which lies just above the cross riffles; when the amalgamated spoon is well loaded with amalgam, it is withdrawn and the excess removed by pressure and a movement of the thumb and finger; the same operation is repeated until a considerable quantity is taken out. It is a very dangerous business, as the miners show but little mercy to those found prowling around the sluices at night.

The clean-up is simple and easy, water is allowed to run through the sluice until it comes out clear at the lower end, several of the upper riffles are then taken out, and while a gentle stream is still flowing, the sand, gold, mercury, and amalgam are swept down to the riffles still in place; a part of the loose sand flows over, and what remains is scooped up and put into a bucket; when all the riffles are successively removed, and all the gold and quicksilver collected, the cleaning is finished in the miner's pan, when all the movable impurities are washed away and nothing but quicksilver and amalgam remain, the whole is poured into a bag of close canvas or chamois leather, and all the superfluous mercury squeezed out; the mercury having been poured from the pan the semi-hard amalgam is taken from the bag, made up into small balls and returned to the clean pan, in which it is carried to the retort. The methods of retorting gold will be described under the proper head.

In some large works block riffles, long tail-races, and a simple form of undercurrent are used, which as they do not differ materially from those common in hydraulic mining, will be fully described under that head.

It must not be supposed that the sluice box collects all the gold contained in the dirt washed through it; such is not the case for many reasons, which will be explained hereafter. It may be stated here that there is no known process by which, on a large scale, all the gold in a given deposit can be wholly extracted.

GROUND SLUICING.

Ground sluicing is another step in the direction of hydraulic mining, larger quantities of water are used than in other methods of placer mining described, and as a consequence more earth is moved. The plan is to bring water in a flume or ditch, to a point high enough to produce a strong current, as it flows across the mining claim. A ditch or "ground sluice" is dug, which is sometimes, but seldom, terminated by a wooden sluice box with riffles. Large quantities of pay dirt are shoveled into the ditch, which is moved forward by the action of the water. The descent should be so great that the water will cut its own channel or bed, a small cutting being first made to lead it in the direction required. If there is no bedrock, stones are thrown into the artificial bed, by which a bedrock is improvised. The side banks are eroded naturally by the action of the water, assisted by the miners, who break it down with pick and shovel. When the water has been used to the best advantage, and a sufficient amount of rich dirt has been washed, the water is shut off, or applied at some other locality, while the clean-up is made. This is done by removing the stones and washing the now concentrated earth with a rocker, long tom, or a short sluice. Ground sluicing is generally practiced in Winter, when water is plenty, and only on ground which it is thought will not pay to work otherwise.

BOOMING OR GOUGING.

This operation is supposed to be an improvement on ground sluicing, from which it differs in being a sudden rush from a reservoir instead of a continuous stream. It has been practiced quite extensively in California, and even now the application has not wholly been abandoned. The first step to work a mine by booming is to plan some convenient and capacious reservoir, in which the required water may be stored. A strong dam is generally thrown across the channel of a mountain stream. The dam is provided with a flood-gate so constructed that the whole contents of the lake can be poured out in a torrent without injuring the dam or washing away the sides of the lake. When the reservoir is full, the gates are opened and the water allowed to rush down in a body with great force, cutting away the banks, and moving, in some cases, large rocks. The water is conducted through ground sluices. When the reservoir is empty, the gates are shut, and while it is again filling, the banks of the stream, now dry, are picked down. The booming is repeated again and again, as long as desirable. The clean-up is made as described under the head of "ground sluicing." In the Mining Press, Vol. 17, page 50, is mentioned a claim at Minersville, Trinity County, which was worked by this method. Six thousand inches of water were set free every few hours, by which trees and huge bowlders were moved by the powerful stream. Below the ground sluices they had bedrock floors, in which the gold was saved.

This mode of mining is very wasteful. The force of the flood is so sudden and powerful that the lighter particles of gold are washed away and lost. Booming is a close imitation of nature. Sudden deluges from the breaking away of accidental barriers in mountain streams are not uncommon. Sometimes a landslide will dam a stream at the lower end of a mountain meadow; a lake is the result, which accumulating in volume and gaining in strength, finally overcomes the obstruction and flows with terrible impetuosity to the valley below, leaving destruction and devastation in its path. Such phenomena, causing great destruction of life and property, are recorded in history. A notable event of this character occurred in the year 1818. Bowlders from the "Glacier de Getroz" filled the channel of the east branch of the Dranse, which traverses the Val de Bagne, in Switzerland. A large lake was formed, which, rising higher and higher, burst forth at last and poured a flood into the valley below, which was utterly devastated. It is a singular fact that a similar accident occurred at the same locality in the year 1595. The so-called "cloud-bursts," common in the tropical deserts of California and Nevada, are of a like nature, but result from sudden condensation of heavy clouds on the sides of mountains. Many otherwise unaccountable geological phenomena are due to these sudden and violent rushes of water.

DAMS, DITCHES, AND RESERVOIRS.

Although Dr. De Groot has treated this branch of the subject very fully in his paper (a supplement to this report), the following interesting and instructive extracts are quoted from the valuable paper on "Hydraulic Mining in California," read before the American Institute of Mining Engineers, by Aug. J. Bowie, Jr., A. M., at the Wilkesbarre meeting, May, 1878:

Dams.

In California the rainfall from the first of May to the middle of October is inconsiderable, and hence, in order to secure a permanent supply of water for the hydraulic mines, it has been, in many cases, necessary to form large reservoirs, in which water is impounded during the rainy season, or while the mountain snows are melting, and which is used to supply the mines during the dry months.

Large dams of earth, timber, or stone have been constructed to form the storage reservoirs. Among the most considerable dams in the State are the Bowman dam; height, 100 feet; catchment, 28.94 square miles. Three dams owned by the Milton Mining and Water Company, forming the English reservoir; the largest of these dams having a height of 131 feet from the deepest portion of its foundation to its summit; this reservoir impounds 618,000,000 cubic feet of water, has a high water area of about 395 acres, and is fed from a catchment basin 12.10 square miles; the cost of these dams has been about $150,000. The Fordyce dam, of the South Yuba Canal Company; height, sixty feet, costing about $160,000; catchment basin, about forty square miles. The Eureka Lake dam, of the Eureka Lake and Yuba Canal Company; height, sixty-eight feet; storage capacity, 630,000,000 cubic feet; high water area, 328 acres; catchment basin, 5.10 square miles. All the foregoing dams are built of dry rubble stone, and faced with a water-tight lining of plank.

The Tuolumne County Water Company has several large dams built of timber cribs. The largest dam built by this company is across the south fork of the Stanislaus River. It is over sixty feet in height, and three hundred feet wide on top (across the stream), forming a reservoir with three hundred acres high water area. Its catchment is of large size, and great freshets pass over the dam. The dam is at an elevation of about 8,000 feet above the sea level. It is built of cribs of round tamarac logs, from two to three feet in diameter, and with no stone filling. The cribs are about eight feet square from log to log (say ten feet center to center), and the timbers pinned together by wooden tree nails. The dam rests for its entire base on solid granite bedrock. The angle of face with horizon is fifty degrees. The face is formed of flattened eight-inch timbers, pinned with wooden tree nails to the crib, and calked with cedar bark. The flood water passes over the crest of the dam for its entire length. The water is drawn off by several gates, one above the other, placed on the inclined water face. When a gate is opened the water flows directly into the interstices of the crib.

The dam was built in 1856, and has needed no repairs. Large derricks lifted the logs into place. The total cost of the dam did not exceed $40,000.

Pine dams, owned by the same company, constructed on the same plan, have decayed, while cedar cribs are still in perfect order.

The Spring Valley Company's Concow reservoir is formed by two earthen dams, each about fifty-five feet in height; one of these dams, which is used as a waste, has its lower side built of heavy brush, embedded in the earth.

The catchment basins of most of these reservoirs embrace bare mountain slopes and valleys, and in ordinary seasons from sixty to eighty per cent. of the rain and snow falls flow into the reservoirs.

The Bowman Reservoir and Dams.

The Bowman dam, owing to its position, has been constructed by the North Bloomfield company with due reference to the possibilities of breaks occurring in the several other reservoirs east of it, and it is intended in any emergency to hold the drainage not only of its own watershed, but also in case of accident to withstand any rush of water from the reservoirs beyond it. It is the largest dam on the coast. The following detailed account of it was written for this paper by Mr. Hamilton Smith, Jr., C. E., who planned and constructed the dam:

This reservoir was designed for the supply of water during the dry season of the year for the Bloomfield hydraulic gravel mine, owned and operated by the North Bloomfield mining company. It is located in a mountain valley, on the head waters of one of the branches of the Yuba river, in Nevada county, California, at an elevation of 5,400 feet above sea level. It is fed from a gross catchment basin of 28.94 square miles. There are a number of other reservoirs owned by the Bloomfield and Eureka Lake companies on the same stream above the Bowman reservoir; the upper one of these is of large size, holding 630,000,000 cubic feet of water. In ordinary seasons these upper reservoirs retain all the water flowing into them; hence the catchment basin of the Bowman is only about twenty-two square miles, except in years of large rainfall. The mean annual rain and snow fall at the Bowman dam has been 77.91 inches for the past five years, of which about seventy-five per cent. flows into the reservoir. Two dams are needed to impound the water. The main one, placed across the narrow gorge forming the outlet of the valley, has a maximum height of one hundred feet (96¼ feet above datum base line), and an extreme length on top of 425 feet. The smaller dam, placed across a gap near the mouth of the valley, has a maximum height of fifty-four feet and an extreme length on top of 210 feet. It is fitted with wasteways, and over it will be discharged all surplus water from the reservoir.

Ordinary high water mark will be fixed at a point four feet below the summit of the main dam, being coincident with the crest of the waste dam. At this height there will be impounded 845,000,000 cubic feet of water, with a surface area of 502 acres. By placing temporary flush boards on the top of the waste dam, the water can be brought up to ninety-five-foot line (above datum base), increasing the quantity of water stored to 920,000,000 cubic feet.

The canyon or stream feeding the reservoir has a maximum flow during great freshets of from 5,000 to 7,000 cubic feet of water per second. The existence of other reservoirs higher up the stream adds to the danger from great floods, and therefore the Bowman dams have been designed to withstand not only the freshets in the canyon, but also any additional influx of water caused by breaking of upper dams.

The main dam rests on solid granite bedrock, which is sufficiently free from seams to prevent any considerable leakage through crevices in the rock, and was built, in the year 1872, to the height of seventy-two feet, being a timber crib formed of cedar and tamarac unhewn logs, firmly notched and bolted together, and solidly filled with loose stone of small size. A skin of pine planking, spiked to the water-face, formed its water-tight lining. During the years 1875 and 1876, the dam was increased to the height of ninety-six and one quarter feet above datum line (one hundred feet extreme height) by filling in a stone embankment on the lower side of the old structure, faced with heavy walls of dry rubble stone of large size. The down stream face-wall is fifteen to sixteen feet thick at the bottom, dimishing to six or eight feet at the top. Most of the face-stone in this are of good size, weighing from three fourths to four and one half tons, and there are many stones of equal weight in the backing. The lower portion of the wall is seventeen and one half feet high, with a batter of fifteen per cent. It is built of heavy stone, with ranged horizontal beds, and with the face-stone tied to the backing with long iron clamps. The upper portion of the wall is built with a slope of forty-five degrees, and the face-stone is bedded on an angle of twenty-two and one half degrees, thus dividing the angle between a horizontal bed and a bed at right angles to the face. No attempt at range work was made in this upper portion of the wall. Above the sixty-eight foot line, ribs of flattened cedar, eight inches thick, are built into the up stream face-wall, and are tied to it by iron rods three fourths inch diameter and five feet long; to these ribs a plank skin is firmly spiked. This planking is of heart sugar pine, three inches thick and eight inches wide, with planed edges fitted with an outgage similar to ship planking. The plank was put on nearly thoroughly seasoned, and swells sufficiently to make the face practically water-tight, without either battens over the joints or calking; the opening at the joints, made by the outgage, suck in small particles of vegetable matter which take the place of calking to a great extent. At the bottom, the plank is fitted closely to firm bedrock and calked with pine wedges. There will be three thicknesses of plank (nine inches in all) placed on the lower twenty-five feet, two thicknesses (six inches) on the next thirty-five feet, and one thickness on the upper thirty-six feet. From past experience, it is believed that this planking will remain sufficiently sound twenty years at least, and then it can readily be replaced. A culvert extends through the dam through which the water is drawn from the reservoir. This culvert is built with heavy dry rubble foundation and walls, and is covered with granite slabs sixteen to eighteen inches thick and six and a third feet long. Three wroughtiron pipes, of No. 12 iron, each eighteen inches in diameter, pass through the water-face of the dam; their upper mouths are protected by a stringer of two-inch plank, anchored to the bedrock. A separate valve or gate is placed at the lower end of each pipe, the water passing through the gates aggregating a flow of 280 cubic feet per second when the three are open, discharges into a covered timber sluice seven and one half feet wide, one and three fourths feet high, passing to the lower edge of the dam, and discharges on the solid bedrock of the creek-bed. The gates are approached by a manway above the sluice. The crest of the dam will be formed by a coping of hewn heart cedar timbers, eighteen inches wide on top, and anchored securely by iron bolts to the stone wall below.

It is not probable that any water will ever pass over the crest of the main dam, but should a break occur at the large reservoir, higher up the stream, when the waste gates at the waste dam are closed, the difference in level between the crest of the main and the waste dams might be insufficient to allow the resulting flood to pass over the waste dam. Additional care was, therefore, taken in building the down-stream face wall of the main dam, so that it can in any such possible emergency resist without injury a large stream of water passing over the crest. Should this happen a large quantity of water would enter the structure, owing to the inclined beds of the face stone and the flat slope of the wall, which would seek its discharge through the interstices purposely left in the nearly vertical portion of the lower wall. To prevent the consequent hydrostatic pressure, which would accumulate at the base of the dam to perhaps twenty pounds to the square inch, from forcing out the lower face of the wall, it was carefully built and tied with iron rods, as before described.

There are 55,000 cubic yards of material in the structure, weighing about 85,000 tons; the hydrostatic pressure, with the water line ninety-five feet above datum against a vertical plane of that height across the cañon at the dam site, will be 21,745 tons. The dam is V shaped, with the vertex of the angle of 165° pointing up stream. This mode of construction adds somewhat to the stability.

The cost of the dam when completed will be $132,000. The rather peculiar construction of this dam was due to the following causes: The stone cliffs in the vicinity of the dam are composed of an exceeding hard granite, with great numbers of short cross seams, thus making it most costly to quarry dimension stone of considerable size. The stone has rarely a good cleavage, and cost of dressing it down to regular beds is hence great.

No limestone is to be found near by, and any lime used must needs have been transported to the work from a long distance. The cost of transport would have been so great as to render the use of lime impracticable.

On the side of the mountain, at the distance of about one mile from the dam, there was a large pile of loose stone, the result of centuries of disintegration of the cliffs above. This stone was too irregular in shape to be used in wall building, but of good quality for an embankment. It was much cheaper to build a tramway to this stone, already quarried by nature, load it on cars, and haul it to the work, than to quarry a smaller quantity from the cliffs nearer the dam.

Hence, the supply of material being abundant, the flat slopes of forty-five degrees for the wall were adopted, which allowed, with safety, very much lighter face walls to be used than would have been the case had they been more vertical.

The stone for the wall as built was quarried from solid rock, and cost, in place, per cubic yard, three or four times more than the loose stone brought from the mountain side. When, in the future, the timber logs forming the cribs in the original seventy-two-foot dam decay, there will be some slight subsidence of superincumbent stone. The depth of the stone is so considerable, and the slopes of the walls so flat, that it is believed this subsidence will not be noticeable.

The waste dam is a crib of round cedar timbers, varying from twelve to thirty inches in diameter, notched down to heart wood at the joints, and firmly bolted with three-quarter and one inch long drift bolts, with the foundation logs fastened to the bedrock with one-and-a-half-inch iron dowels. The crib, or rather, the successive cribs, are solidly filled with granite stones of various sizes, from several tons down to a few pounds. No sand or fine stone was used in this filling. A plank facing of three-inch heart sugar pine is spiked on the water face, making a water-tight lining similar to that on the main dam. The crest of the dam is ninety-two and one fourth feet above datum line, being, as stated before, four feet lower than the summit of the main dam. In it are cut twenty-eight waste ways, each four feet in width, and having a depth of seven feet below the crest. These wastes are closed when all danger from freshets is passed, with boards two inches thick, eight inches wide, four and one half feet long, placed horizontally, and sliding to their places one above the other on the inclined slope of the water face. This style of gate, though the simplest form known, has been found by long experience to be the very best.

The weight of the dam is about 6,500 tons, and the hydrostatic pressure, with the water line at ninety-five feet above datum against a vertical plane of that height across its upper face, will be 2,571 tons. It is believed that the structure is sufficiently stable to allow with safety a flood of 16,000 cubic feet of water per second to pass through the wastes and over its crest. The water passing over the dam will fall on bare granite bedrock, and thence flows down a steep gorge. From past experience in the use of cedar timber, it is safe to assume that the life of this structure will be from twenty-five to thirty years, and possibly longer. Its cost has been $15,000.

Storage Reservoirs.

When water is not taken from running streams the mines are dependent for their supply on the winter rains and snows. Large reservoirs are built to catch the water from the rains and melting snows, and store it in the Spring and Summer months for use during the dry season.

The North Bloomfield Company has established a complete system of storage reservoirs. The Bowman reservoir, and the small reservoirs about it, will hold, when the main dam is completed to a height of ninety-six feet three inches, about 1,000,000,000 cubic feet of water. The cost of the reservoirs and dam to date is $214,392 06.

The Rudyard reservoir of the Milton Company contains 535,000,000 cubic feet of water, or 3,980,000,000 gallons. Their reservoir is formed by three dams; highest, one hundred feet vertical, and its cost was $150,000. The storage reservoirs of the Eureka Lake and Yuba Coal Company, consisting of the French, Weaver Lake, and Foucherie reservoirs, have an estimated aggregate capacity of 819,800,000 cubic feet of water. Independent of these reservoirs, all mines at a convenient distance from their works have what are called distributing reservoirs. From these places water is easily distributed to the claims, or they are used to retain the surplus coming from the main ditch when the claims are shut down.

Ditches.

Thousands of miles of ditches have been built throughout the State for the purpose of conveying water to the mines, and in some instances are now being used likewise for irrigation. The use of steep grades for running water, the construction of high flumes, and the successful introduction and use of wrought iron pipes, are all due to hydraulic mining. In locating mining ditches, the following rules or principles should be observed:

1. The securing of an abundant and permanent supply of water, particularly during the Summer months.
2. That the source of supply be at a sufficient elevation to cover the greatest range of mining ground at the smallest expense, hydrostatic pressure being always desirable.
3. The snow line, when possible, should be avoided, and the line should be located so as to have a southern exposure, particularly in the snow regions.
4. All watercourses on the line of the ditch should be secured. Their supply partially counteracts the losses by evaporation, leakage, and absorption, and frequently furnishes an additional quantum of water during several months of the year.
5. Waste-gates, at proper intervals, should be arranged so as to discharge the water, when necessary, without risk of damage to the ditch.
6. Ditches, when practicable and the cost not excessive, should always be preferred to flumes.

Amongst the principal ditches constructed in the State are the North Bloomfield, Milton, Eureka Lake, San Juan, South Yuba Canal, Excelsior or China Ditch, Bouyer and Union, El Dorado, Cherokee and Spring Valley, Hendricks, and La Grange.

The North Bloomfield main ditch, including distributors, is fifty-five miles long. Its size is 8.65 feet on top, five feet at the bottom, and three and one half feet deep. The ditch and distributors cost $422,106 22. Its grade is from twelve to sixteen feet per mile, discharging 3,200 miner's inches. The Milton Company's ditches are one hundred miles long, and their average grade is from twelve to twenty-five feet to the mile. The size of the main ditch is four feet on bottom, six feet on top, and three and one half feet deep, discharging 3,000 miner's inches. Cost, $259,020 14. The Eureka Lake ditch is eighteen miles long, and has a capacity of 2,500 miner's inches. Its cost, including water rights and flumes, was $430,250. The San Juan ditch and branches extend some forty-five miles in length. The main ditch is thirty-two miles long, and its capacity is 1,300 miner's inches. The cost was $293,092. These two last mentioned ditches belong to the Eureka Lake and Yuba Canal Company.

The main ditch of the South Yuba Canal Company, (from the head to Bear River, one and a half miles long,) is six feet wide on top, five feet deep, with a grade of thirteen feet per mile. Its present capacity is 7,000 miner's inches. From Bear Valley (junction of Dutch Flat ditch with the main ditch) the size of the canal for the succeeding three and one half miles is six feet wide on top, four and one half feet deep, and has a grade of eight feet to the mile. The Dutch Flat branch, or ditch, is thirteen miles long; its size is six and one half feet on top, four feet deep, and has a grade of thirteen and one half feet per mile; the capacity of this ditch is 3,150 miner's inches of water. The Chalk Bluff ditch is six feet wide on top, and five feet deep, with a grade of sixteen feet per mile, delivering, it is said, 4,100 miner's inches of water. The several ditches, etc., owned by the South Yuba Canal Company, have an aggregate length of 123 miles. The Excelsior or China ditch, at Smartsville, is thirty-three miles long. Size, five feet bottom, eight feet on top, and carries four feet of water. The grade is nine feet to the mile, and the ditch discharges 1,700 Smartsville miner's inches. The Bouyer and Union ditches are respectively about fifteen miles long. Size, four feet on bottom, eight feet on top, carrying three and one half feet of water. Their grades are thirteen feet to the mile, each ditch discharging 1,200 Smartsville miner's inches. There are several minor ditches which deliver water in and around Smartsville. The total capacity of all the ditches is 5,000 Smartsville miner's inches, and the whole investment in this class of property in this locality approximates $1,200,000.

The Spring Valley and Cherokee ditch is fifty-two miles long, and has three and one half miles of iron pipe, thirty inches in diameter. The size of the ditch averages five feet wide, three and one half feet deep, discharging about 2,000 inches of water.

The Hendricks ditch, in Butte County, is forty-six and one half miles long. Grade of the upper line of ditch, 12.8 feet per mile. Grade of the lower line, 6.4 per mile. Respective sizes, five feet wide, two feet deep. Total cost, including Glen Beatson ditch and Oregon Gûlch ditch, $136,150.

The La Grange ditch, including Patricksville branch, is over twenty miles in length. Size, nine feet on top, six feet bottom, four feet deep. Grade from seven to eight feet to the mile. The greater part of the ditch is cut in granite, and in places there are solid walls, fifty to seventy feet high, built of stone. It discharges 3,000 miner's inches of water, and its cost to date is about $450,000.

General Observations.

Ditches in California, with carrying capacities as large as eighty cubic feet per second, have been built, and are now in successful operation, with grades of from sixteen to twenty feet per mile. In a mountainous country, where steep grades can be generally obtained by a slight increase in the length of the canal, and where the cost of excavation is large, a great saving can be effected by using the smallest sized canals and aqueducts practicable to carry the given quantity of water; or, in other words, by running water rapidly through a small channel, rather than slowly through a large one. It is found to be safer and more economical, on account of the deep snows and terrific storms which rage in the mountains during the winter, to run and maintain in repair narrow and deep ditches on heavy grades than broad ones with light grades. The experience of ditch builders in this State has been highly favorable to these steep grades, but little trouble being caused by the washing of the banks due to high velocities. In the valleys with ashy soil such grades, of course, would not be practicable.

Waterworks in Nevada County, California.

[*Nevada City Transcript.*]

	Miles.	Cost.
North Bloomfield Company	157	$708,841 00
Milton Company	80	391,576 00
Eureka Lake Company	163	723,342 00
South Yuba Water and Mining Company	123	561,688 00
Blue Tent Company	32	150,000 00
Excelsior Water and Mining Company	115	525,156 00
Totals	670	$3,060,603 00

The following tables, published by Joshua Hendy, of San Francisco, will be found useful in calculations pertaining to canals, ditches, and flumes:

TABLE NO. 1.

Flow of Water in Open Channels—Base to perpendicular of the side slopes being as 3:4.

Fall per Mile. Feet.	Fall per Rod. Inches.	T 2.2 ft. B 1.0 ft. D .8 ft. Section 1.28 sq. ft. Cu. ft.	T 3.3 ft. B 1.5 ft. D 1.2 ft. Section 2.88 sq. ft. Cu. ft.	T 4.4 ft. B 2.0 ft. D 1.6 ft. Section 5.12 sq. ft. Cu. ft.	T 5.5 ft. B 2.5 ft. D 2.0 ft. Section 8.0 sq. ft. Cu. ft.	T 6.6 ft. B 3.0 ft. D 2.4 ft. Section 11.52 sq. ft. Cu. ft.	T 7.7 ft. B 3.5 ft. D 2.8 ft. Section 15.68 sq. ft. Cu. ft.	T 8.8 ft. B 4.0 ft. D 3.2 ft. Section 20.48 sq. ft. Cu. ft.
1	.0375	.45	1.33	2.67	5.57	9.05	13.46	20.26
2	.0750	.63	1.88	3.87	7.88	12.80	19.04	28.64
3	.1125	.77	2.30	4.74	9.65	15.67	23.32	35.08
4	.1500	.89	2.65	5.47	11.14	18.52	26.93	40.51
5	.1875	1.00	2.97	6.12	12.46	20.24	30.11	45.30
6	.2250	1.09	3.25	6.70	13.65	22.17	32.98	49.62
7	.2625	1.18	3.42	7.24	14.74	23.94	35.63	53.58
8	.3000	1.26	3.75	7.73	15.75	25.60	38.08	57.28
9	.3375	1.34	3.98	8.21	16.71	27.15	40.39	60.76
10	.3750	1.41	4.19	8.65	17.61	28.62	42.57	64.05
11	.4125	1.48	4.40	9.07	18.47	30.02	44.65	67.18
12	.4500	1.54	4.60	9.48	19.30	31.35	46.64	70.65
13	.4875	1.61	4.78	9.86	20.08	32.63	48.54	73.03
14	.5250	1.67	4.96	10.24	20.84	33.87	50.38	75.79
15	.5625	1.73	5.14	10.60	21.57	35.05	52.14	78.44
16	.6000	1.78	5.31	10.94	22.27	36.20	53.86	81.02
17	.6375	1.84	5.47	11.28	22.96	37.31	55.51	83.51
18	.6750	1.89	5.63	11.60	23.63	38.39	57.11	85.93
19	.7125	1.94	5.78	11.92	24.28	39.44	58.58	88.29
20	.7500	1.99	5.93	12.23	24.91	40.47	60.21	90.58
21	.7875	2.04	6.08	12.54	25.53	41.47	61.70	92.82
22	.8250	2.09	6.22	12.83	26.12	42.45	63.15	95.00
23	.8625	2.14	6.36	13.12	26.71	43.40	64.57	97.15
24	.9000	2.18	6.50	13.40	27.29	44.34	65.95	99.23
25	.9375	2.23	6.63	13.68	27.98	45.24	67.32	101.28

In the Table, T signifies top width; B, bottom width; D, depth.

TABLE No. 1—Continued.

Flow of water in Open Channels—Base to perpendicular of the side slopes being as 3:4.

Fall per Mile. Feet.	Fall per Rod. Inches.	T 9.9 ft. B 4.5 ft. D 3.6 ft. Section 25.92 sq ft. Cu. ft.	T 11 ft. B 5 ft. D 4 ft. Section 32 sq. ft. Cu. ft.	T 13.2 ft B 6.0 ft. D 4.8 ft. Section 46.09 sq. ft. Cu. ft.	T 16.4 ft. B 7.0 ft. D 5.6 ft. Section 62.72 sq. ft. Cu. ft.	T 17.6 ft. B 8.0 ft. D 6.4 ft. Section 81.92 sq. ft. Cu. ft.	T 19.8 ft. B 9.0 ft. D 7.2 ft. Section 103.68 sq. ft. Cu. ft.	T 22 ft. B 10 ft. D 8 ft. Section 128 sq. ft. Cu. ft.
1	.0375	28.04	37.1	58.4	96.5	138.3	189.2	261.2
2	.0750	39.67	52.4	82.7	136.4	195.7	267.6	369.4
3	.1125	48.59	64.2	101.4	167.1	239.6	327.7	451.3
4	.1500	56.10	74.1	117.1	192.9	276.7	378.4	522.3
5	.1875	62.71	82.9	130.9	215.7	309.3	423.1	584.0
6	.2250	68.70	90.8	143.4	236.3	338.8	463.5	639.8
7	.2625	74.19	98.1	154.8	255.3	366.0	500.5	691.0
8	.3000	79.53	104.8	165.5	272.9	391.2	535.1	738.7
9	.3375	84.14	111.1	175.6	289.4	415.0	567.6	783.5
10	.3750	88.68	117.1	185.1	305.0	437.4	598.2	825.9
11	.4125	93.02	122.9	194.1	319.9	458.7	613.2	866.2
12	.4500	97.15	128.4	202.8	334.2	479.1	655.4	925.6
13	.4875	101.13	133.6	211.1	347.8	498.7	682.1	941.7
14	.5250	104.94	138.7	219.0	360.9	517.5	707.8	977.2
15	.5625	108.63	143.5	226.6	373.6	535.7	732.8	1011.5
16	.6000	112.18	148.2	234.1	385.9	553.3	756.7	1044.7
17	.6375	115.64	152.4	241.3	397.8	570.3	780.1	1076.9
18	.6750	118.99	157.2	248.3	409.3	586.9	802.7	1108.1
19	.7125	122.26	161.5	255.1	420.5	601.5	824.8	1138.4
20	.7500	125.43	165.7	261.7	431.4	618.5	846.1	1168.0
21	.7875	128.53	169.8	268.2	442.0	633.9	867.0	1196.8
22	.8250	131.55	173.8	274.5	452.5	648.8	887.4	1225.0
23	.8625	134.51	177.7	280.7	462.9	663.4	907.4	1252.6
24	.9000	137.40	181.5	286.7	472.6	677.7	926.9	1279.5
25	.9375	140.24	185.3	292.6	482.3	691.6	946.0	1306.0

In the Table, T signifies top width; B, bottom width; D, depth.

TABLE NO. 2.

Flow of Water in Open Channels—Base to perpendicular of the side slopes being as 2:1.

Fall per Mile. Feet.	Fall per Rod. Inches.	T 6 ft. B 2 ft. D 1 ft. Section 4 sq. ft. Cu. ft.	T 9 ft. B 3 ft. D 1.5 ft. Section 9 sq. ft. Cu. ft.	T 12 ft. B 4 ft. D 2 ft. Section 16 sq. ft. Cu. ft.	T 16 ft. B 6 ft. D 2.5 ft. Section 27.5. sq. ft. Cu. ft.	T 22 ft. B 10 ft. D 3 ft. Section 48 sq. ft. Cu. ft.	T 28 ft. B 12 ft. D 4 ft. Section 30 sq. ft. Cu. ft.	T 40 ft. B 20 ft. D 5 ft. Section 150 sq. ft. Cu. ft.
.5	.01875	1.27	3.85	8.63	18.11	38.79	78.2	188.1
.6667	.0250	1.46	4.44	9.96	20.91	44.79	90.3	217.2
.8333	.03125	1.63	4.96	11.14	23.38	50.08	101.0	242.8
1.	.0375	1.79	5.44	12.20	25.61	54.86	110.6	266.0
1.25	.046875	2.00	6.08	13.64	28.68	61.32	123.7	297.4
1.5	.05625	2.19	6.67	14.96	21.34	67.26	135.7	326.1
1.75	.065625	2.37	7.19	16.14	33.88	72.57	146.4	351.8
2.	.0750	2.53	7.69	17.26	36.22	77.58	156.5	376.1
2.25	.084375	2.68	8.16	18.30	38.42	82.29	165.9	399.0
2.5	.09375	2.83	8.60	19.29	40.50	86.72	174.9	420.6
3.	.1125	3.10	9.42	21.14	44.36	95.00	191.6	460.7
3.5	.13125	3.35	10.17	22.83	47.91	102.60	207.0	497.6
4.	.1500	3.58	10.87	24.41	51.22	109.70	221.3	531.9
4.5	.16875	3.79	11.54	25.88	54.33	116.30	234.7	564.2
5.	.1875	4.00	12.16	27.29	57.27	122.70	247.4	594.8
6.	.2250	4.38	13.31	29.89	62.74	134.40	271.0	651.5
7.	.2625	4.73	14.39	32.29	67.78	145.10	292.7	703.6
8.	.3000	5.06	15.38	34.52	72.43	155.20	312.9	752.2
9.	.3375	5.37	16.31	36.61	76.83	164.60	331.9	797.9
10.	.3750	5.66	17.19	38.59	80.99	173.50	349.9	841.1
11.	.4125	5.93	18.03	40.47	84.94	181.90	366.9	882.1
12.	.4500	6.20	18.74	42.27	88.72	190.10	383.2	921.3

In the Table, T signifies top width; B, bottom width; D, depth

TO DETERMINE THE CAPACITY OF DITCHES, CANALS, OR FLUMES.

In cases where the sectional areas are equal, but of different forms:

The simplest form of construction of a ditch or canal is that in which the width of the bottom is made equal to one of the sides, and in which the base to the perpendicular of the side slope is as 3:4; and this form has been adopted as the standard where the topography of the ground will admit.

The relative carrying capacity for trapezoidal form, base: depth of slope : : 3:4; bottom width : depth : : 5:4. Coefficiency of capacity=1,000.

Trapezoidal form, base: depth of slope : : 1:1; bottom width=depth, .994.

Flume, 2:1, .961; semi-hexagonal, 1.008; square, 925; semi-circular, 1.056.

The fall being eight feet to the mile, and the sectional area of a square flume being 11.52 square feet, what will be its carrying capacity per second?

In Table No. 1, in column headed "fall per mile," find the given fall eight feet, and opposite in column headed (6′.6″-3′-2′.4″) or a sectional area of 11′.52 square feet will be found 25.60 cubic feet, which, multiplied by the coefficient for a square given above, gives 25.60×.925= 23.68 cubic feet, or ×.50=1184 miner's inches.

The tables given to determine the flow of water through ditches, canals, or flumes have been computed upon the assumption that they are generally smooth and straight.

HYDRAULIC MINING.

It has been shown that the surface placers in California soon became exhausted, and the collection of gold from less accessible sources more and more difficult, requiring large outlay of capital and labor.

Hydraulic mining is the outgrowth of the already described modes of placer mining. It is the application of natural forces to move large quantities of earthy matter, and the collection of a certain quantity of gold so small as not to admit of its being profitably saved by any of the earlier methods. To be successful, certain conditions must exist, which can only be found in a newly settled mountainous country. These conditions are as follows: An abundant supply of water, which must be free, or which can be purchased cheaply; a deposit of loose, easily disintegrated earth, which contains gold in sufficient quantity to pay for working; bedrock not too deep below the surface; a channel into which the debris can be discharged; high ground above the claims, to which the water can be conveyed to give the required pressure.

The ancients were good hydraulic miners and engineers, as illustrated by their works, some of which are still in good condition. Father Secchi has called attention to these facts in a letter to the French Academy of Science. The first mention is an aqueduct built at Alatri—a town in Italy—two hundred years before the Christian era. It is an inverted syphon, the lowest depression being one hundred and one meters, or three hundred and thirty-eight feet below the point from which the water flowed into the town. At the lowest point it sustains a pressure equal to eleven atmospheres. The pipes are of earthenware, imbedded in a heavy work of concrete. The length of the pipe is eleven and a half miles. The whole is still in a good state of preservation.

The following extract from Pliny's Natural History, Bohn's edition, Vol. 6, p. 99, will show that they carried on extensive hydraulic mining enterprises much as we do now:

HOW GOLD IS FOUND.

Gold is found in our part of the world, not to mention the gold extracted from the earth in India by the ants, and in Scythia by the griffins. Among us it is procured in three different ways; the first of which is in the shape of dust, found in running streams, the Tagus in Spain, for instance, the Padus in Italy, the Hebrus in Thracia, the Pactolus in Asia, and the Ganges in India. Indeed, there is no gold found in a more perfect state than this, thoroughly polished as it is by the continual attrition of the current.

A second mode of obtaining gold is by sinking shafts or seeking it among the debris of the mountains, both of which methods it will be well to describe. The persons in search of gold in the first place remove the "segutilum," such being the name of the earth which gives indication of the presence of gold. This done, a bed is made, the sand of which is washed, and according to the residue found after washing, a conjecture is formed as to the richness of the vein. Sometimes, indeed, gold is found at once in the surface earth, a success, however, but rarely experienced. Recently, for instance, in the reign of Nero, a vein was discovered in Dalmatia, which yielded daily as much as fifty pounds weight of gold. The gold that is thus found in the surface crust is known as "talutium," in cases where there is auriferous earth beneath. The mountains of Spain, in other respects arid and sterile, and productive of nothing whatever, are thus constrained by man to be fertile, in supplying him with this precious commodity.

The gold that is extracted from shafts is known by some persons as "canalicium," and by others as "canaliense." It is found adhering to the gritty crust of marble, and altogether different from the form in which it sparkles in the sapphirus of the East, and in the stone of Thebais and other gems, it is seen interlaced with the molecules of the marble. The channels of these veins are found running in various directions along the sides of the shafts, and hence the name of the gold they yield, "canalicium." In these shafts, too, the superincumbent earth is kept from falling in by means of wooden pillars. The substance that is extracted is first broken up and then washed, after which it is subjected to the action of fire and ground to a fine powder. This powder is known as "apitascudes," while the silver which becomes disengaged in the furnace has the name of "sudor" given to it. The impurities that escape by the chimney, as in the case of all other metals, are known by the name of "scoria." In the case of gold, this scoria is broken up a second time and melted over again. The crucibles used for this purpose are made of "tasconium," a white earth similar to potter's clay in appearance, there being no other substance capable of withstanding the strong current of air, the action of the fire, and the intense heat of the melted metal.

The third method of obtaining gold surpasses the labors of the giants even. By the aid of galleries driven to a long distance, mountains are excavated by the light of torches, the duration of which forms the set times for work, the workmen never seeing the light of day for many months together. These mines are known as "arrugiæ," and not unfrequently the clefts are formed on a sudden, the earth sinks in, and the workmen are crushed beneath; so that it would really appear less rash to go in search of pearls and purples at the bottom of the sea, so much more dangerous to ourselves have we made the earth than the water. Hence it is that in this kind of mining, arches are left at frequent intervals for the purpose of supporting the weight of the mountain above. In mining either by shaft or by gallery, barriers of silex are met with, which have to be driven asunder by the aid of fire and vinegar, or more frequently, as this method fills the galleries with suffocating vapors and smoke, to be broken to pieces with bruising machines shod with pieces of iron weighing one hundred and fifty pounds; which done, the fragments are carried out on the workmen's shoulders, night and day, each man passing them on to his neighbor in the dark, it being only those at the pit's mouth that ever see the light. In cases where the bed of silex appears too thick to admit of being penetrated, the miner traces along the sides of it, and so turns. And yet, after all, the labor entailed by this silex is looked upon as comparatively easy, there being an earth—a kind of potter's clay mixed with gravel—"gangadia" by name, which it is almost impossible to overcome. This earth has to be attacked with iron wedges and hammers, like those previously mentioned, and it is generally considered that there is nothing more stubborn in existence—except, indeed, the greed for gold, which is the most stubborn of all things.

When these operations are all completed, beginning at the last, they cut away the wooden pillars at the point where they support the roof. The coming downfall gives warning, which is instantly perceived by the sentinel, and by him only, who is set to watch upon a peak of the same mountain. By voice as well as by signals, he orders the workmen to be immediately removed from their labors, and, at the same moment, takes to flight himself. The mountain, rent to pieces, is cleft asunder, hurling its debris to a distance with a crash which it is impossible for the human imagination to conceive; and from the midst of a cloud of dust, of a density quite incredible, the victorious miners gaze upon this downfall of nature. Nor yet, even then, are they sure of gold, nor, indeed, were they by any means certain that there was any to be found when they first began to excavate, it being quite sufficient, as an inducement to undergo such perils and to incur such vast expense, to entertain the hope that they shall obtain what they so eagerly desire.

Another labor, too, quite equal to this, and one which entails even greater expense, is that of bringing rivers from the more elevated mountain heights, a distance, in many instances, of one hundred miles, perhaps, for the purpose of washing these debris. The channels thus formed are called "corrugi," from our word, "corrivatio," I suppose; and even when these are once made, they entail a thousand fresh labors. The fall, for instance, must be steep, that the water may be precipitated, so to say, rather than flow; and it is in this manner that it is brought from the most elevated points. Then, too, valleys and crevasses have to be united by the aid of aqueducts, and in another place impassable rocks have to be hewn away and forced to make room for hollowed troughs of wood, the persons hewing them hanging suspended all the time with ropes, so that to a spectator who views the operations from a distance, the workmen have all the appearance, not so much of wild beasts as of birds upon the wing. Hanging thus suspended in most instances, they take the levels, and trace with lines the course the water is to take; and thus, where there is no room, even for man to plant a footstep, are rivers traced out by the hand of man.

The water, too, is considered in an unfit state for washing if the current of the river carries any mud along with it. The kind of earth that yields this mud is known as "wrium," and hence it is that in tracing out these channels, they carry the water over beds of silex or pebbles, and carefully avoid this wrium. When they have reached the head of the fall, at the very brow of the mountain, reservoirs are hollowed out a couple of hundred feet in length and breadth, and some ten feet in depth. In these reservoirs there are generally five sluices left, about three feet sqnare; so that, the moment the reservoir is filled, the flood-gates are struck away, and the torrent bursts forth with such a degree of violence as to roll onward any fragments of rock which may obstruct its passage.

When they have reached the level ground, too, there is still another labor that awaits them. Trenches—known as "agogœ"—have to be dug for the passage of the water; and these, at regular intervals, have a layer of ulex placed at the bottom.

This ulex is a plant like rosemary in appearance, rough and prickly, and well adapted for arresting any pieces of gold that may be carried along. The sides, too, are closed in with planks, and are supported by arches when carried over steep and precipitous spots. The earth, carried onwards in the stream, arrives at the sea at last, and thus is the shattered mountain washed away—causes which have greatly tended to extend the shores of Spain by these encroachments upon the deep. It is also by the agency of canals of this description that the material, excavated at the cost of such immense labor by the process previously described, is washed and carried away, for otherwise the shafts would soon be choked up by it.

The gold found by excavating with galleries does not require to be melted, but is pure gold at once. In these excavations, too, it is found in lumps, as also in the shafts which are sunk, sometimes exceeding ten pounds even. The names given to these lumps are "palagæ," and "palacurnæ," while the gold found in small grains is known as "baluce." The ulex that is used for the above purpose is dried and burnt, after which the ashes of it are washed upon a bed of grassy turf, in order that the gold may be deposited thereupon.

Asturia, Gallæcia, and Lusitania, furnish in this manner, yearly, according to some authorities, twenty thousand pounds weight of gold, the produce of Asturia forming the major part. Indeed, there is no part of the world that, for centuries, has maintained such a continuous fertility in gold. I have already mentioned that, by an ancient decree of the Senate, the soil of Italy has been protected from these researches; otherwise there would be no land more fertile in metals. There is extant also a censorial law relative to the gold mines of Victumulœ, in the territory of Vercellœ, by which the farmers of the revenue were forbidden to employ more than five thousand men at the works.

SOURCES AND SUPPLY OF WATER.

The water which supplies the hydraulic mines of California is taken from mountain lakes and mountain streams at a point sufficiently high to admit of its being brought to the most elevated gold deposits. When it is known that the North Bloomfield mines are more than 3,000 feet above sea level, the full meaning of this statement will be realized. It is not only necessary to find a source of water at a greater altitude than the mines, but this excess must be, in some cases, sufficient to allow fall in a canal many miles long, and it must be possible to find a passage for the water without permitting it to fall below the required level. The engineering feats performed in conveying water are of such a nature as to surprise those who see them for the first time. It was formerly the invariable rule, when a deep cañon was to be crossed, to build an aqueduct of timber over it, upon which the flume was supported. Some of these flumes were a marvel of mechanical skill. It is not uncommon to see flumes on trestle-work 130 feet from the ground at the highest parts. One of the most extensive flumes in the State is near Big Oak Flat, in Tuolumne County. At Empire Flat, in Nevada County, there is a very large and elevated flume, which now supplies the Empire Diggings with water. Many of these costly flumes, so common in California in early times, have been allowed to fall into decay. The placer mines supplied by them having been exhausted, other methods were introduced which, to a great extent, have taken the place of the wooden structures.

With the advent of iron pipes, the introduction of which has been gradual, it was found that they would bear a water pressure much greater than could have been supposed until experiment had been made to prove it. There are but few instances where it is not possible to conduct the water in a V-shaped bend in an iron pipe to the bottom of the cañon and up the opposite side. The ditch or flume receiving the water from the pipe must be considerably below the point where the pipe takes it from the canal or ditch. The largest pipes for this service are about thirty inches in diameter. If the volume of water is too great to pass through a pipe of this size, two are laid, side by side. The Spring Valley Company's Cherokee Ditch, in Butte County, is a striking example of this improved method. The cañon or valley is cut by the Feather River; 12,000 feet of thirty-inch pipe are used in the crossing, and the greatest pressure sustained is 887 feet, which would have been thought impossible in the early stages of hydraulic mining. The Miocene Company, at Oroville, Butte County, convey 3,000 miner's inches of water through a flume suspended on iron brackets set in the face of a cliff, 200 feet above the ground. Some of the ditches or canals in the State are many miles in length. These few examples are given to show what an amount of labor, capital, and engineering skill have been expended in looking up these supplies and conveying the water to points where it could be used to advantage. The whole surface of the mining regions in the different counties of the State is interlaced with these canals and ditches. Dr. DeGroot has treated this subject at greater length, and Mr. Robinson has shown in his paper that, should mining, in the future, wholly cease, the water would still be used for agricultural, manufacturing, and town supply purposes, to the great advantage of California.

The following extracts are from the admirable paper on Hydraulic Mining by Aug. J. Bowie, M. E., read before the American Institute of Mining Engineers, at the Wilkesbarre meeting, May, 1877, and republished in the Mining and Scientific Press of San Francisco, Vol. 35:

THE DEFINITION OF HYDRAULIC MINING.

Hydraulic mining may be defined as the art of extracting gold from gold-bearing detritus—*i. e.*, surface deposits, placers, or washings—by means of water under great pressure discharged through pipes against the auriferous material. In working these gold deposits by this method, it is essential to success that there should be: first, economical management; second, ample facilities for grade and dump; third, a sufficient head and an abundant supply of cheap water. As regards the "economical management," the same can be considered a *sine qua non* for success in all enterprises, but is especially requisite here, as the value of this kind of mining is based on the great facility with which profitable results can be readily obtained, at a trifling cost from washing vast areas of ground which contain relatively, per cubic yard, insignificant amounts of precious metal, but in the aggregate, when expeditiously and skillfully worked, give large remunerative returns.

The pioneer miner, after working out the river bars, followed up the stream to find "the source of the gold." Its existence was discovered from slides, denudations, and breaks in channels, which subsequent explorations proved to be the ancient river system of the State, whose general course is nearly at right angles to the present river system of California.

The indefatigable prospector, advancing further into the unexplored mountains, again discovered gravel beds at elevations of several thousand feet above the present water-level. The streams flowing through the precipitous cañons of the high Sierras aided materially in the development and discovery of the gold fields. Their waters were soon appropriated for gold washing, and thus was inaugurated the system of mining ditches, which to-day extends over several thousand miles.

The immense gold-bearing drift inclosed between channel walls, or "rim rock," as it is called, was explored by means of tunnels driven in from bordering cañons, tapping the bottom of the deposit, enabling the extraction of the pay stratum, which was subsequently sluiced to extract the gold. This style of mining received the name of "deep placer mining."

Little by little the "top-dirt" of these deposits, composed chiefly of light soil, clay, fine gravel, and streaks of sand, was washed off, and in places considerable gold was thus obtained. Canvas hose was brought into use to convey the water over the banks for the dirt washing, and from this originated hydraulic mining. In the progress of the work strata were found composed of bowlders, pebbles, quartz, sand, and various rocks cemented together, requiring the use of powder to break them up. The color of this cement was in places white or reddish, and sometimes blue.

Shafts sunk in these strata discovered the presence of gold in great abundance, and a fresh enthusiasm was thus infused into gravel mining, already on the wane, as the river bars were becoming exhausted.

THE GOLD-BEARING DEPOSITS OF CALIFORNIA.

The auriferous deposits of California are chiefly confined to the western slope of the Sierra Nevada mountains. The principal counties in which placer mining is carried on are: Shasta, Trinity, Plumas, Sierra, portions of the east side of Butte and Yuba Counties; also, Nevada, Placer, El Dorado, Amador, Calaveras, Tuolumne, Mariposa, and Stanislaus Counties. "It is here," says Professor Whitney, "that the belt of metamorphic slates and sandstones, which is peculiarly the gold-bearing formation of the State, is developed to its greatest width, and least concealed from the miners' explorations by the presence of overlying, non-metalliferous formations. It is here that the physical conditions have most favored the concentration of the gold in the detrital formation, so that it could be obtained by simple washing, without the necessity of mining for it in the solid rock, and perhaps more readily and more abundantly than any region ever opened to seekers after the precious metal."

The gold deposits are found in river channels, in basins, and on flats; also, as isolated rolling hills, and occur either as accumulations of gravel alone, resting directly on the surface, or as accumulations of detritus, consisting of gravel, sand, drift, pebbles, and bowlders of all sizes, covered with lava and other volcanic products. Their geological ages are Post-Tertiary and Tertiary.

The section of the country which is of immediate interest to the miner is the western slope of the Sierras. These mountains, rising in a short distance from the Sacramento plains to elevations of over 7,000 feet, with occasional peaks 10,000 and 12,000 feet high, are cut by numerous deep and precipitous gorges, or cañons, through which drains the immense water shed of the Sierras, supplying the main rivers of the State, and ultimately emptying into the Pacific Ocean.

Between these cañons, ridges or divides are formed, on top of which gold placers are found. These gold-bearing surface deposits extend from Shasta in the north to Kern County in the south, the most extensive deposits occurring in Plumas, Sierra, Placer, and Nevada Counties. The term "shallow placers" is applied to deposits of gravel and earth whose thickness varies from a few inches to five or six feet in depth, to distinguish them from deep placers, or detrital accumulations found in ancient channels covering large areas, and varying from one hundred to several hundred feet in depth.

MEASURING BOX.

The water company delivers water to the miner from a measuring box, from which it is only possible to draw the amount agreed upon. A miner's inch, generally understood, is the quantity of water which will flow in ten hours from a vertical aperture one inch square, the center of which being six inches below a constant level of the water in the reservoir. Some measuring boxes are furnished with openings two or four inches wide, but the heighth of the water in the box is so maintained that the quantity discharged is the same. Certain customs prevail in different localities as to the miner's inch, and the price also varies, being governed by the law of supply and demand. Some miners use the water ten hours, others twelve hours, while still others take it continuously for twenty-four hours. In speaking of these quantities, they are called ten-hour inches, twelve-hour inches, or twenty-four-hour inches, as the case may be, and the price paid is governed by the quantity used.

The miner's inch under a six-inch pressure is equal to 94.7 cubic feet per hour. In some localities the pressure is ten inches, which is equal, according to Mr. Amos Bowman, to 109.1 cubic feet per hour. Mr. Bowman gives the average of the miner's inch as 100 cubic feet per hour, or 1,000 cubic feet per day of ten hours, which will fill a cubic tank ten feet deep. He also offers the wise suggestion that, for convenience in calculation and for a convenient standard, the miner's inch shall be made to deliver 100 cubic feet per hour.

The following extracts are from Mr. Bowie's paper:

The miner's inch is an arbitrary measurement of water established in early days by the miners in the different camps, in accordance with the laws they adopted. The miner's inch, as accepted in some districts, is an amount of water discharged from an opening one inch square through a two-inch plank, with a pressure of six inches above the opening.

The Smartsville inch is calculated from a discharge through a four-inch orifice, with a seven-inch board top; that is to say, that the pressure is seven inches above the opening, or nine inches from its center. The bottom of the aperture is on a level with the bottom of the box, and the board which regulates the pressure is a plank one inch thick and seven inches deep. Thus an opening 250 inches long and four inches wide, with a pressure of seven inches above the top of the orifice, will discharge 1,000 Smartsville miner's inches. Each square inch of the opening will discharge 1.76 cubic feet per minute, which approximates the discharge per inch of a two-inch orifice through a three-inch plank, with a pressure of nine inches from the center of the opening, the said discharge being 1.78 cubic feet per minute. The Smartsville miner's inch will discharge 2,534.40 cubic feet in twenty-four hours, though in that district the inch is only reckoned for eleven hours.

The miner's inch of the Park Canal and Mining Company, El Dorado County, discharges 1.39 cubic feet of water per minute. The inch of the South Yuba Canal Company is computed from a discharge aperture two inches wide, through a one and a half inch plank, with a pressure of six inches from the center of orifice.

At the North Bloomfield, Milton and La Grange Mines, the inch has been calculated from a discharge through an opening fifty inches long and two inches wide, through a three-inch plank, with the water seven inches above the center of the opening.

To determine the value of this miner's inch, a series of experiments were made at Columbia Hill, latitude 39° N.; elevation, 2,900 feet above sea level. The module used was a rectangular slit, fifty inches long and two inches wide, pressure seven inches above the center of the opening. The discharge was over a three-inch plank, the last inch chamfered. The size of the opening was taken with a measure (micrometer attached) which had been compared with and adjusted to a standard United States yard. Time was read to one fifth of a second. The following results were obtained:

	Cubic feet.
One miner's inch will discharge in one second	.2624
One miner's inch will discharge in one minute	1.5744
One miner's inch will discharge in one hour	94.4640
One miner's inch will discharge in twenty-four hours	2,267.1360

Ratio of actual to theoretical discharge, 61.6 per cent. These figures are within the limit of 1-500 possible error.

A series of experiments made at La Grange, to determine the effective value of the above described inch, gave the following results:

	Cubic feet.
One miner's inch discharged in one second	.2499
One miner's inch discharged in one minute	1.5744
One miner's inch discharged in one hour	89.9640
One miner's inch discharged in twenty-four hours	2,159.1460

Ratio of effective to theoretical discharge, 59.05 per cent.

PRESSURE BOX.

From the measuring box, the water is conducted to the pressure box, called also a sand box and bulkhead. The name "sand box" is given, because the well constructed pressure box has a sand box in connection with it. When the water is owned by the company using it, the measuring box is also combined in the pressure box. The sand box is frequently put into the bed of the ditch which conveys the water to the mines, at several points along its course, according to the quantity of impurity present. When so used, or when combined with the pressure box, its construction is the same. It is so arranged that it will arrest and retain sand and small gravel that may be held in suspense and carried along by the force of the current. The sand box varies in dimensions with the capacity of the ditch. It not only extends across the whole bed of the ditch, but is wide in proportion to the amount of sand which the water contains. When required to be of extraordinary size, it is placed outside the ditch with which it is connected by flumes, which take the water from, and return it to, the ditch, after it has been divested of its sandy impurity. When placed in the ditch, it is several feet below the bed, forming a depression into which the sand falls. The sand box is provided with a door or gate, through which the accumulation may from time to time be sluiced out.

After the water from a mining ditch has been used and returned to it at a lower level, which is frequently the case, it is so highly charged with sand and finely divided suspended mineral matter, that it is found necessary to purify it by mechanical means. This is done by running it into large tanks or reservoirs, generally natural depressions cut by mountain streams, across which a dam has been built. The water having been let into the reservoir it is allowed to settle—the water being drawn from the lower end in the same sized stream which enters at the upper.

The pressure box proper is a wooden cistern larger or smaller in proportion to the size of the pipes to be supplied and the diameter of the nozzle used. It is built on an elevation at the proper altitude above the mine, and at a point which is accessible to the ditch from which it is intended to draw the supply of water. It is made of two inch planks, strengthened by a strong frame of timbers. It is set perfectly level. There are several rules to be observed in the construction of the pressure box, each of which is of great importance. No sticks or floating matter must be allowed to enter the iron pipes. To guard against this, gratings of vertical bars are arranged, which intercept all floating rubbish. From time to time, as matter accumulates at the gratings, it is thrown out either by hand or by the aid of an iron fork.

The water in the pressure box must be without motion before it enters the pipes, or air will be carried down, which will cause a disturbance and produce an intermittent stream at the nozzle. To secure this quiet, the water is received into one apartment—which serves also for a sand box—from which it flows through a latteral opening into the pressure box. In the inspection of many pressure boxes I did not find any two exactly alike, although the general principle was the same in all.

In some cases the pressure box for a single pipe is divided into three compartments, built of two-inch plank in a frame-work of ten-inch timbers. The water falls into the outer chamber or sand box, the bottom of which is lower, to admit of the settling of the sand and small gravel. When the water rises to the level of the second compartment it passes through a vertical grating of round iron bars half an inch in diameter, set three inches apart. This grating intercepts all pieces of wood and other floating rubbish. From the center compartment, the water flows into the pressure box through a similar grating, in which the rods are set half an inch apart, which catch the leaves and smaller floating bodies that may have passed the coarser grating.

From this third compartment the iron pipe emerges, being flanged and spiked to the plank inside. There being no pressure here the iron is light. When working properly, all the boxes are full of water, which enters the iron pipe quietly and without air. The slight excess flows over a depression in the upper edge of one of the compartments, which is a shallow water-gate; but when the water is paid for this waste is made as small as possible, by closing the gates which supply the measuring box.

When two pipes lead from the same pressure box the sand box is sometimes placed in the center. The usual size of the sand box is ten by twenty feet in the single, and twelve to thirty feet in the double. There are much larger boxes in use which combine the pressure, sand and measuring box, in one.

The Polar Star and Southern Cross, at Dutch Flat, Placer County, take the water from the same box, which is double. The water is conveyed from the ditch of the South Yuba Ditch Company, through a wooden flume twenty-four feet long. This flume conveys the water to the measuring box, all floating refuse being arrested by a grating of wooden bars set at an angle of thirty-five degrees, any rubbish meeting this grating is carried by the force of the water above the stream, and is thrown out from time to time. The measuring box is eighteen by twenty-one feet square and about three feet deep. On both sides and on the front, there are lateral openings or slits, four inches wide, through which the water flows. These openings extend the whole length of the sides and the front. The number of miner's inches that they deliver in a day is known, and upon that calculation the water is received from the water company and paid for. The water from the measuring box falls into an outer box set at a lower level, and which extends on three sides. From this outer box the water falls four feet into double channels, which narrow as they extend forward and connect with sand boxes, from which it flows into the pressure boxes. After having been freed from floating objects by secondary gratings, the water passes to the mines through the iron pipes. When it is required to diminish the quantity of water for any reason, the slits in the measuring box are partially closed, and to make the joints tight, a shovel full of saw-dust is thrown in, which finds the small leaks and fills them. For this purpose, and to fill the joints in the pipes, a quantity of this substance is kept in a convenient place near by.

The pressure boxes in use at North Bloomfield, in Nevada County, are peculiar. While on the same general plan, they differ in detail. The one I visited was double, two pipes being supplied. It was about twenty feet long, and about twelve feet wide. The sand in this box falls under a wooden diaphragm into a large chamber provided with a door, through which it can be sluiced out when required.

There is sometimes a small reservoir, called a regulator, near the pressure boxes, with a gate which is opened by turning a large screw, each turn of which has a known value in miner's inches and decimals. Into the regulator, already full, a certain number of inches of water are turned by the company supplying it. There is, however, enough in the regulator to supply the pipes for several hours, should there be any irregularity or stoppage.

The following tables, prepared by P. M. Randall, are given with the assurance that they are simple and reliable and furnish important data for the solution of many problems in hydraulics.

TABLE NO. 3.

Flow of Water through Rectangular Orifices in thin Vertical Partitions.

Head upon Center of Orifice.	Velocity per Second.	Breadth and Height of Orifice.									
		1 ft. High. 1 ft. Wide.		9 in. High. 1 ft. Wide.		6 in. High. 1 ft. Wide.		3 in. High. 1 ft. Wide.		1.5 in. High. 1 ft Wide.	
Feet.	Feet.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P,
0.2	3.58									0.28	.0064
.3	4.40							0.69	.022	.34	.010
.4	5.07					1.56	.071	.80	.036	.40	.018
.5	5.67			2.57	.146	1.74	.099	.89	.051	.45	.026
.6	6.22	3.72	.253	2.83	.193	1.91	.130	.98	.066	.49	.033
.7	6.72	4.02	.317	3.06	.249	2.07	.165	1.06	.082	.53	.041
.8	6.38	4.31	.392	3.27	.297	2.21	.201	1.14	.104	.57	.052
.9	7.62	4.57	.467	3.48	.356	2.35	.240	1.20	.122	.60	.061
1.0	8.025	4.87	.554	3.67	.417	2.48	.281	1.26	.144	.63	.072
1.25	8.99	5.29	.751	4.02	.571	2.71	.385	1.39	.197	.69	.098
1.50	9.83	5.92	1.01	4.50	.767	3.03	.517	1.55	.259	.77	.129
1.75	10.59	6.40	1.27	4.86	.967	3.27	.650	1.67	.326	.83	.163
2.00	11.35	6.85	1.56	5.20	1.18	3.50	.795	1.79	.398	.89	.199
2.25	12.00	7.27	1.86	5.51	1.41	3.71	.949	1.89	.475	.95	.237
2.50	12.68	7.67	2.18	5.81	1.65	3.91	1.11	1.99	.565	1.00	.283
2.75	13.32	8.05	2.53	6.09	1.86	4.10	1.28	2.09	.654	1.04	.327
3.00	13.90	8.41	2.87	6.36	2.17	4.27	1 46	2.18	.743	1.09	.371
3.50	15.01	9.08	3.61	6.86	2.73	4.61	1.83	2.35	.935	1.17	.467
4.00	16.05	9.97	4.54	7.32	3.33	4.92	2.24	2.50	1.14	1.25	.568
4.50	17.02	10.29	5.26	7.75	3.96	5.21	2.66	2.65	1.36	1.32	.678
5.00	17.95	10.84	6.16	8.16	4.64	5.49	3.12	2.78	1.58	1.39	.781
6.	19.66	11.84	8.08	8.91	6.08	5.98	4.08	3.03	2.07	1.51	1.03
7.	21.23	12.76	10.14	9.61	7.64	6.43	5.12	3.24	2.58	1.62	1.29
8.	22.71	13.64	12.40	10.25	9 32	6.84	6.22	3.45	3.14	1.71	1.50
9.	24.70	14.47	14.80	10.86	11.11	7.25	7.42	3.64	3.72	1.83	1.82
10.	25.38	15.25	17.34	11.44	13.00	7.62	8.66	3.83	4.34	1.92	2.18
15.	31.08	18.68	31.85	14.01	23.88	9.34	15.93	4.09	8.00	2.36	4.02
20.	35.89	21.50	49.05	16.18	36.78	10.80	24.55	5.42	12.29	2.72	6.15
25.	40.13	24.12	68.52	18.10	51.42	12.08	34.32	6.06	17.22	3.05	8.67
30.	43.95	26.43	90.10	19.84	67.64	13.47	45.92	6.64	22.64	3.35	11.42
35.	47.47	28.55	113.6	21.44	85.27	14.31	56.96	7.18	28.56	3.62	14.40
40.	50.75	30.53	138.8	22.94	104.3	15.32	69.64	7.68	34.91	3.79	17.23
45.	53.83	32.39	165.6	24.35	124.5	16.26	83.14	8.16	41.73	4.12	21.02
50.	56.75	34.15	194.0	25.68	145.8	17.16	97.50	8.61	48.92	4.35	24.72

TO DETERMINE THE FLOW OF WATER THROUGH RECTANGULAR GATES OR OPENINGS IN THIN PARTITIONS.

The head being twenty feet and the opening being six inches high and one foot wide, what will be the discharge in miner's inches.

In Table No. 3, opposite 20 feet in first column, find in column "6 inches high, 1 foot wide," 10.80 cubic feet. Multiply this number by fifty, the number of miner's inches in one cubic foot, and we have 10.80x50=540.00 miner's inches.

The head being twenty feet, and the opening being six inches high and one foot wide, what number of pounds of water will be discharged each second?

In Table No. 3, opposite 20 feet in first column, find in column headed "6 inches high, 1 foot wide," 10.80 cubic feet. Multiply this number by 62.5, the number of pounds in one cubic foot 10.80x62.5=675 pounds.

The head being twenty feet and the opening one inch high and one foot wide, what will be the discharge in cubic feet?

In Table No. 3, opposite 20 feet in first column, find in column headed "3 inches high, one foot wide," 5.42 cubic feet. The given height one inch being one third of three inches, the height of the opening, we may take one third of the flow through three inches for given opening and have as the worth 5.42÷3=1.81 cubic feet.

TABLE NO. 4.

Flow of Water over Weirs per Second for Each Foot in Length of Weir.

Head from still water.		Flow per second, 1 foot in length.	Head from still water.		Flow per second, 1 foot in length.	Head from still water.		Flow per second, 1 foot in length.
Feet.	Inches.	Cubic feet.	Feet.	Inches.	Cubic feet.	Feet.	Inches.	Cubic feet.
0	0.48	.026	0	5.52	1.039	1	2.40	4.390
0	0.60	.037	0	5.76	1.107	1	3.60	4.951
0	0.72	.048	0	6.00	1.177	1	4.80	5.531
0	0.84	.060	0	6.24	1.248	1	6.00	6.134
0	0.96	.074	0	6.48	1.321	1	7.20	6.756
0	1.08	.088	0	6.72	1.395	1	8.40	7.399
0	1.20	.104	0	6.96	1.472	1	9.60	8.052
0	1.32	.120	0	7.20	1.551	1	10.80	8.732
0	1.44	.137	0	7.44	1.629	2	0.00	9.430
0	1.56	.154	0	7.68	1.708	2	1.20	10.146
0	1.68	.172	0	7.92	1.789	2	2.40	10.869
0	1.80	.191	0	8.16	1.871	2	3.60	11.619
0	1.92	.210	0	8.40	1.960	2	4.80	12.385
0	2.04	.230	0	8.64	2.038	2	6.00	13.167
0	2.16	.251	0	8.88	2.124	2	7.20	13.965
0	2.28	.273	0	9.12	2.212	2	8.40	14.778
0	2.40	.295	0	9.36	2.300	2	9.60	15.607
0	2.64	.341	0	9.60	2.388	2	10.80	16.450
0	2.88	.388	0	9.84	2.479	3	0.00	17.309
0	3.12	.438	0	10.08	2.570	3	1.20	18.181
0	3.36	.489	0	10.32	2.662	3	2.90	19.068
0	3.60	.545	0	10.56	2.756	3	3.60	19.969
0	3.84	.593	0	10.80	2.850	3	4.80	20.795
0	4.08	.657	0	11.04	2.946	3	6.00	21.719
0	4.32	.716	0	11.28	3.043	3	7.20	22.657
0	4.56	.776	0	11.52	3.141	3	8.40	23.607
0	4.80	.838	0	11.76	3.240	3	9.60	24.571
0	5.04	.902	1	0.00	3.339	3	10.80	25.547
0	5.28	.972	1	1.20	3.852	4	0.00	26.536

TO DETERMINE THE FLOW OF WATER OVER WEIRS, PER SECOND, FOR EACH FOOT IN LENGTH OF WEIR.

The head from still water being ten inches, what will be the flow over one foot in length of a weir?

In Table No 4, in third column, headed "Head from still water," find 10.08 inches (the nearest approximate number to ten inches), and opposite, in column headed "Flow per second, one foot in length," will be found the quantity of flow=2.570 cubic feet, or 128.5 miner's inches.

Pressure of Water per Square Inch at Different Heads.

P=Pressure in lbs. per square inch.
H=Head of water in feet.
$P=H\times .4333.$ $H=P\times 2.31.$

One cubic foot of fresh water weighs 62.5 lbs.

For convenience in calculating head, I have constructed the following table:

TABLE NO. 5,

For calculating Hydrostatic Pressure.

HEAD, IN FEET.	Pressure, in lbs., per square in.	HEAD, IN FEET.	Pressure, in lbs., per square in.
One	0.434028	Sixty	26.041665
Two	0.868056	Seventy	30.381943
Three	1.302083	Eighty	34.722220
Five	2.170139	Ninety	39.062498
Ten	4.340278	One hundred	43.402775
Twenty	8.680555	Two hundred	86.805550
Thirty	13.020833	Three hundred	130.208325
Forty	17.361110	Four hundred	173.611100
Fifty	21.701388	Five hundred	217.013875

The manner of using this table is very simple. If the head is found in the first column the pressure is known by simple inspection. If not, the head must be made up as in the following example: Suppose the head to be 174.5 feet, the pressure will be found as follows, which will be understood by a moment's study of the table:

100 =43.402775
70 =30.381943
3 = 1.302083
1 = 0.434028
0.5= 0.217013

174.5=75.737842

IRON PIPES.

From the pressure box the water is conveyed in iron pipes to the gravel banks which contain the gold.

Canvas hose were in general use in 1853. They would bear a pressure of eighty to one hundred feet while discharging water through a two-inch nozzle. Flexible canvas hose was first made of heavy cotton duck, closely sewn. Without strengthening they would only bear a pressure of fifty feet, or about twenty-two pounds to the square inch. They were afterwards strengthened by bands of iron, placed three inches apart, and held in place by four cords extending longitudinally. This form of hose was called "the crinoline." So constructed they were able to resist a pressure of one hundred and eighty feet, or seventy-eight pounds to the square inch. Some canvas hose were strengthened by a netting of strong cord or rope, while others were "served" with rope, as sailors wrap a hawser or shroud to protect it against wear. In some localities canvas or gum hose are still used, but only where hydraulic or drift mining is conducted upon the smallest scale.

The discovery of the superiority of wrought-iron riveted pipe to all others before known is due to progressive hydraulic mining.

While castiron pipes are more durable they are more expensive, both in first cost, freight, and labor required in laying, the wrought-iron pipe has the advantage of being strong and light, and may, without great expense, be relaid or moved when occasion requires; such pipes bear a pressure which, in former times, would be considered impossible. It has been found that a twenty-two-inch pipe, of

No. 14 iron, will resist a pressure of 300 feet head, or one hundred and thirty pounds to the square inch, and an eleven-inch pipe, of No. 16 iron, a pressure of 500 feet, or 217 pounds to the inch. No. 14 iron is 0.083 of an inch thick, and weighs 3.35 pounds to the square foot; No. 16 is 0.065 of an inch thick and 2.63 pounds to the foot. Persons having no practical experience, will generally make their pipes unnecessarily heavy.

The manufacture of iron pipe is very simple. American iron is used; the sheets are taken to a machine which punches all the holes at a single motion; the sheets are then curved, lapped, and riveted; the joints are from twenty-four to thirty inches long; the rivets used are proportional to the size of the pipes; the short lengths are then riveted together in lengths of fifteen to twenty-eight feet; the short joints are slightly tapered, so that the small end of one will fit into the large end of another; the long sections are dipped into a bath of hot asphaltum; the pipes are lifted by machinery and allowed to remain in the bath until they have acquired the temperature of the melted asphaltum. It is claimed that a pipe so prepared will last, under ground, for twenty years, and this may be regarded as the extreme term of usefulness for first class hydraulic pipe. A single row of rivets is generally all that are required, but in some cases, where great strength is desired, a double row is used.

These iron pipes were formerly made at San Francisco, Sacramento, and Marysville, but now a large portion of the iron is sent to the locality where it is to be used, and the pipe made on the ground. Sometimes the iron is punched at the machine shop and packed in bundles to be made into joints at the mine; some companies buy the iron and do all the work themselves.

One firm in San Francisco commenced making iron pipe in the year 1856, on a small scale, it is now sent from their establishment to Colorado, Nevada, Oregon, Montana, Idaho, South America, Central America, and Mexico. One lot was sent to a mine south of Aspinwall, on the Atlantic side.

Wrought iron pipe is not only used for hydraulic mining, but for other water works. The firm mentioned has put in ten miles at Menlo Park, nine miles at Petaluma, six at Santa Rosa, two at Cloverdale, three each at Carson City and Winnemucca, two miles at Reno, three miles at San Buenaventura, four at Santa Barbara, and smaller lengths at many other places.

Iron pipes are made of sheets of a graduated strength, according to the pressure to be resisted; they are larger and lighter near the pressure box, and smaller and stronger near the nozzle.

It has been found by experience that it is not necessary to rivet the sections of pipe together; in fact, unless it can be protected from changes in temperature, a continuous pipe many hundreds of feet in length, and strongly riveted together, would be subject to an inconvenient movement, if not in continual danger of breaking; the joints are simply slipped into each other like a stovepipe, until the line is as long as required; the wide ends are toward the pressure boxes, the ends are entered, and a rope strap put on each section; a strong tackle hooked on, and the lengths drawn together; one strand of marline is then caulked in, and the edges hammered down.

Iron pipes expand and contract with every change of temperature. In a hot day it can be seen where the joints have slipped several inches. In some parts of the pipe this contraction is so great as to endanger the pipe. In such a case an iron band is used, to give strength and at the same time to admit of expansion and contraction, so arranged that the slip does not cause a leak. These bands are from three to twelve inches wide. Several plans have been adopted to draw them tight. There is always a bandage of canvas or gunny sack laid under the iron band; the common method of fastening is by set screws or wedges. The system by screws is the most convenient to put on, but the threads soon become rusty and the screws are difficult to remove, while if a wedge is used it can be struck out by a blow from a hammer, no matter how rusty it may have become.

Mr. E. W. Towle, of Dutch Flat, made some experiments as to the expansion of pipes by heat. He found that a three quarter inch gas pipe two hundred and sixty-feet long, through which steam was passed, increased in length nine inches.

This expansion becomes at times quite annoying, and when convenient, the pipes are covered either with earth or boards, to protect them against the sun's heat. Rough boards are also required to protect the pipes against falling rocks thrown up in blasting bowlders. According to its degree of inclination, the pipe requires to be firmly braced, and at certain points to be weighted down with rocks, a secure foundation being a consideratum.

When water is let into the pipes, air is displaced, but sometimes collects in the highest elevations. This causes the pipe to undulate, or to "buck," as it is technically called. To allow the air to escape, an ingenious valve has been devised. At regular intervals on the upper curved surface of the pipe, oval holes are cut three by four inches. On the inside of the pipe, valves of sole leather, strengthened by plates of iron or brass, are so attached that a pressure from below forces them up, closing the hole. The hinge is at the upper end of the hole, or that part nearest to the source of the stream. The flow of water shuts the valve, and the pressure holds it in place. To allow the air to escape, a weighted lever extends lengthwise along the pipe, which carries a wooden pin or dowell set against the closed valve. The weight is so regulated as to force down the valve against the pressure of air, but to yield to that of the water. As long as the air only acts on the valve, the dowell forced down by the weighted box, opens the valve and allows the air to escape. When the pipe is full of water, the valve and weight become inoperative. Every change in the position of the nozzle causes the pipe to undulate. The effect is shown at the pressure box, and the gates have to be adjusted. The pipes should be kept well painted. The pipes of the Polar Star and Southern Cross, at Dutch Flat, are in a remarkably good state of preservation, which is mainly owing to the fact that they are protected by heavy coats of paint.

The distributor, formerly in common use, consists of a strong iron box, which, on receiving the water from the supply pipe, passes it out through as many apertures in its several faces as there are streams to be played in the mine, four of which sometimes issue from a single distributor. To each of these apertures there is attached a smaller iron pipe for conducting the water to the several nozzles. The water is shut off from these pipes by iron gates. The distributor is only useful with a small head. The enormous pipes now in use, carrying several thousand inches of water under a pressure of hundreds of feet head, cannot be shut off from below. Nothing in use would stand such a shock or pressure. When it is required to shut off the water, it must be done at the head. For this reason, the distributor has gone out of use, and has been replaced by the "twin" and the "triplet." The "twin" is a fork in the pipe, by which a portion of the water is conducted to one point and a portion to another. The two branches are used at alternate intervals, each supplying a nozzle in different parts of the claim, or two nozzles are supplied at the same time. In the latter case, the branch pipes are of half the capacity of the supply pipe; and in the former, both the supply pipe and the two branches are of the same diameter. In both cases there are strong gates in both branches, closed from above by a screw. The "triplet" has three branches. What has been said of the "twin" applies equally to the "triplet." The "twins" and "triplets" are weak points in the pipe, and require to be especially strengthened. The joints are not only braced by strong timbers; but are weighted down by heavy piles of stones.

One of the most remarkable instances of wrought iron pipes under great pressure is the inverted syphon, which supplies the Cherokee gravel mines of Butte County with water. The following facts are mainly from an article published in the Mining and Scientific Press of January 7, 1871, a portion of which is quoted:

This region has been worked to some extent for many years, but only during the Winter months, with such water as could be obtained from reservoirs in the rainy season. From its elevation, however, there was but little opportunity for collecting water, and hence the locality, although known to be rich, has received but comparatively little attention.

The success of the sheetiron pipe used by the Spring Valley Water Company of San Francisco, led to the employment of one of greater magnitude, in the locality first spoken of, and induced Messrs. Judson, Abbey, Davis and Doe to undertake to convey water to the Cherokee mines. A ditch had been constructed from Concore Creek to Yankee Hill, and from this place the water had to be carried across the ravine of the west branch to the opposite mountain, whence it was conducted in a canal to the mines of Cherokee Flat.

The inlet to the pipe is 150 feet above the outlet, with a vertical height from the lowest point to grade line of 900 feet. The pipe is thirty inches in diameter, and is intended to carry 1,900 miner's inches of water. The water is admitted at the upper end from a cistern, with sand-box, etc., for settling any sand or gravel brought in from the ditch. The pipe has here an elbow, dipping into the water, to prevent the entrance of any air. Fifty feet from the inlet there is a sand-pipe to allow the escape of any air which may have got into the pipe, and to guard against an overhead of water. At different places, especially where depressions occur, are placed air valves, made with floats, to allow the escape of air, which shut on the approach of water. If the water is drawn off, these open on the inside, preventing the collapsing of the pipe from atmospheric pressure.

The pipe was laid in a trench (five feet deep) from one end to the other, and covered with earth to prevent any undue expansion and contraction in hot and cold weather. It does not extend quite to the bottom of the ravine, but is carried over on a truss-bridge at a height of about seventy feet. It was laid in lengths of twenty-three feet, which were riveted one to the other continuously, manholes being placed every 1,000 feet to allow the entrance of the workmen.

The following table will show the thickness of the iron used, weight, pressure, etc.:

TABLE NO. 6.

HEAD—IN FEET.	Pressure—pounds to square inch	Number of iron.	Thickness of iron, in inches.	Weight of iron per square foot.	Rivets used.
One hundred and fifty	65	14	0.083	3.35	$\frac{1}{4}$
Two hundred and seventy-five	119	12	0.100	4.40	$\frac{1}{4}$
Three hundred and fifty	152	10	0.134	5.43	$\frac{5}{16}$
Four hundred and twenty-five	184	7	0.180	7.27	$\frac{3}{8}$
Six hundred	260	--------	0.250	10.09	------
Eight hundred and fifty	369	--------	0.312	12.58	------
Nine hundred	391	--------	0.375	15.10	------

The pipes were partly riveted cold and partly hot; partly by hand and partly by machine. All the rivets less than three eighths were driven cold; five sixteenths, three eighths, and three fourths were driven hot.

A steam riveting machine was employed for nearly all of the pipe, giving better results than the hand labor.

The pipe was made at the rate of 1,100 feet per day, giving employment to a large number of men. The punching and shearing was done by machinery expressly designed for this pipe, and as high as thirty tons of iron were worked daily, 87,000 feet of pipe being manufactured and laid in place, and the water run through, in four months from the commencement of the enterprise.

The thickness of iron required gives a datum for computing the comparative cost of cast-iron and of wrought-iron pipe; three eighths wrought iron sustains here a pressure of three hundred and ninety-one pounds to the square inch, for which three-inch cast iron (nearly) would be required to make it safe. The freight alone of such a cast-iron pipe would render the enterprise impracticable.

Such is a brief outline of one of the greatest undertakings of the kind ever attempted, and one which opens a new and rich mineral region. That a work of such magnitude and boldness should be conceived and carried out, redounds greatly to the honor of our Pacific Coast. It speaks most highly for the talent of the engineers who conceived the plan, the enterprise of the men who undertook to put it in execution, and the ability of the mechanics who made it an accomplished fact.

For fuller particulars the reader is referred to the original article in the Mining and Scientific Press.

Water was let into the pipes in December, 1871; it required three hours and forty minutes for them to fill, which took place without accident. Ten years have passed and the work is as effective as when laid.

The size of iron pipes varies in different localities, with the amount of water required, the extent of the works, and the capital available. At the Manzanita Mine at Nevada City, Nevada County, seven-inch pipe is used, which widens upward to twelve or fourteen inches at a small pressure box, which is fed by a twelve-inch flume. The pressure box is two by four feet, by five feet deep. There is no sand box, except a space below the pipe which has a small gate in the side through which to sluice the sand. No. 14 iron is generally used at Dutch Flat, Placer County. At the twin in the Bonanza Mine at Gold Run, Placer County, all the pipes are sixteen inches. At the Malakoff Mine, North Bloomfield, Nevada County, the pipe at the head is twenty-seven inches, narrowing to twenty-two, and fifteen at the nozzle. At the American Mine, near North San Juan, Nevada County, the pipes are consecutively thirty-four, twenty-two and fifteen inches.

The Cedar Creek Water and Mining Company's supply pipe which crosses the upper washings of the Polar Star and Southern Cross mines at Dutch Flat, Placer County, is thirty inches in diameter; it is made of No. 12 iron.

The pipes of the Southern Cross and Polar Star both lead from the same pressure box, as before stated. The former is forty inches and the latter forty-eight inches in diameter. The upper part is made of No. 16 and the lower of No. 14 iron. They taper for five hundred feet to twenty-two inches; and run parallel for twenty-eight hundred feet, to twins, at which the pipe is reduced to fifteen inches. From the twins branches extend to different parts of the claims; the pressure at the lowest points is about five hundred feet. These pipes cost $7,500 each.

The following statement as to the cost of iron pipes in the North Bloomfield mines is from the published report of that company: 65.5 feet of 22-inch No. 12 iron cost $157 20; 694 feet of 18-inch No. 16

iron cost $416 40; 250 feet of 22-inch No. 12 iron cost $505 00. Total investment in iron pipes $18,926 03.

The following table, by P. M. Randall and furnished by Johsua Hendy, San Francisco, will be found useful in calculating various problems connected with the construction of iron pipes:

TABLE NO. 7.

Areas of Circles.

Diameter.	AREAS. 0.	⅛	¼	⅜	½	⅝	¾	⅞
0	.0	.0122	.0490	.1104	.1963	.3068	.4417	.6013
1	.7854	.9940	1.227	1.484	1.767	2.073	2.405	2.761
2	3.141	3.546	3.976	4.430	4.908	5.411	5.939	6.491
3	7.068	7.669	8.295	8.946	9.621	10.32	11.04	11.76
4	12.56	13.36	14.18	15.03	15.90	16.80	17.72	18.66
5	19.63	20.62	21.64	22.69	23.75	24.85	25.96	27.10
6	28.27	29.46	30.67	31.91	33.18	34.47	35.78	37.12
7	38.48	29.87	41.28	42.71	44.17	45.66	47.17	48.70
8	50.26	51.84	53.45	55.08	56.74	58.42	60.13	61.86
9	63.61	65.39	67.20	69.02	70.88	72.75	74.66	76.58
10	78.54	80.51	82.51	84.54	86.95	88.66	90.76	92.88
11	95.03	97.20	99.40	101.6	103.8	106.1	108.4	110.7
12	113.0	115.4	117.8	120.2	122.7	125.1	127.6	130.1
13	132.7	135.2	137.8	140.5	143.1	145.8	148.4	151.2
14	153.9	156.6	159.4	162.2	165.1	167.9	170.8	173.7
15	176.7	179.6	182.6	185.6	188.6	191.7	194.8	197.9
16	201.0	204.2	207.3	210.5	213.8	217.0	220.3	223.6
17	226.9	230.3	233.7	237.1	240.5	243.9	247.4	250.9
18	254.4	258.0	261.5	265.1	268.8	272.4	276.1	279.8
19	283.5	287.2	291.0	294.8	298.6	302.4	306.3	310.2
20	314.1	318.1	322.0	326.0	330.0	334.1	338.1	342.2
21	346.3	350.4	354.6	358.8	363.0	367.2	371.5	375.8
22	380.1	384.4	388.8	393.2	397.6	402.0	406.4	410.9
23	415.4	420.0	424.5	249.1	433.7	438.3	443.0	447.6
24	452.3	457.1	461.8	466.6	471.4	476.2	481.1	485.9
25	490.8	495.7	500.7	505.7	510.7	515.7	520.7	525.8
26	530.9	536.0	541.1	546.3	551.5	556.7	562.0	567.2
27	572.5	577.8	583.2	588.5	593.9	599.3	604.8	610.2
28	615.7	621.2	626.7	632.3	637.9	643.5	649.1	654.8
29	660.5	666.2	671.9	677.7	683.4	689.2	695.1	700.9
30	706.8	712.7	718.6	724.6	730.6	736.6	742.6	748.6
35	962.1	968.9	975.9	982.8	989.8	996.8	1004.	1011.
40	1257.	1265.	1272.	1280.	1288.	1296.	1304.	1312.
45	1590.	1599.	1608.	1617.	1626.	1635.	1644.	1653.
50	1964.	1973.	1983.	1903.	2003.	2013.	2023.	2033.
60	2827.	2839.	2851.	2862.	2875.	2887.	2899.	2911.

RIVETED JOINTS.

The following table, from Prescott, Scott & Co.'s pamphlet, gives the size and the distance apart of rivets necessary to produce a substantial and steam-tight joint in boiler iron of different thicknesses. Taking the strength of the plate as 100, the strength of double riveted joints will be 70, and those which are single riveted will be 50.

TABLE NO. 8.

Thickness of sheet by Birmingham gauge	Diameter of rivets	Length of rivets	Number of rivets per pound	Center to center of rivets, single riveting	Center to center of rivets, double riveting	Center to center of rivets crosswise	Width of lap, single riveting	Width of lap, double riveting
⅜ in.	⅝	2	3½	1¾	2½	1¾	2½	3½
No. 1	⅝	1¾	4	1¾	2½	1¾	2½	3½
No. 3	⅝	1⅝	5	1¾	2½	1¾	2¼	3¼
No. 5	½	1⅝	6	1½	2	1½	2	3
No. 7	7/16	1½	7	1⅜	1¾	1¼	2	3
No. 10	5/16	1	35	1⅛	1½	1	1¾	2¾
No. 12	¼	⅞	65	1⅛	1⅜	⅞	1½	2½
No. 14	¼	⅞	65	1	1¼	¾	1¼	2¼
No. 16	¼	¾	70	⅞	1⅛	⅝	1⅛	2
No. 18	⅛	¾	100	¾	1	½	1⅛	1⅞
No. 20	⅛	½	110	½	¾	⅜	1	1¾

TABLE NO. 9.

Weight of Sheet and Plate Wire—Thickness by Birmingham Wire Gauge and Inches—Weight of a Square Foot in Pounds.

THICKNESS.		Weight. Pounds.	THICKNESS.		Weight. Pounds.
B. W. Gauge.	Part of an inch.		B. W. Gauge.	Part of an inch.	
36	.004	.126	11	.120	4.48
35	.005	.202		⅛ or .125	5.054
34	.007	.283	10	.134	5.426
33	.008	.322	9	.148	5.98
32	.009	.364		5/32 or ·1562	6.305
31	.010	.405	8	.165	6.605
30	.012	.485	7	.180	7.27
29	.013	.526		3/16 or .1875	7.578
28	.014	.595	6	.203	8.005
27	.016	.677		7/32 or .2187	8.79
26	.018	.755	5	.22	8.912
25	.020	.811	4	.238	9.62
24	.022	.912		¼ or .25	10.09
23	.025	1.018	3	.259	10.37
22	.028	1.137		9/32 or .2812	11.38
	1/32 or .03125	1.259	2	.284	11.525
21	.032	1.31	1	.3	12.15
20	.035	1.416		5/16 or .3125	12.58
19	.042	1.695	0	.340	13.750
18	.049	1.975		11/32 or .3437	13.875
17	.058	2.35		⅜ or .375	15.10
16	.065	2.637	00	.380	15.26
	1/16 or .0625	2.518		13/32 or .4062	16.34
15	.072	2.92	000	.425	17.125
14	.083	3.35		7/16 or .4375	17.65
	3/32 or .0937	3.78	0000	.454	18.30
13	.095	3.85		15/32 or .4607	18.90
12	.100	4.4	00000	½ or .50	20.00

For steel plates, multiply tabular number above (for size) by 1 01.

Weight of Sheet and Plate Iron—Continued.

Thickness in Inches—Weight of a Square Foot in Pounds.

Inches thick.	Lbs. per sq. foot.	Inches thick.	Lbs. per sq. foot.	Inches thick.	Lbs. per sq. foot.	Inches thick.	Lbs. per sq. foot.	Inches thick.	Lbs. per sq. foot.	Inches thick.	Lbs. per sq. foot.
9/16	22.50	3/16	47.90	1 3/4	70.62	3/4	111.00	3 7/8	156.51	1/8	206.90
5/8	25.21	1/4	50.45	1 13/16	73.14	7/8	116.10	4	161.55	1/4	211.95
13/16	27.75	5/16	52.96	7/8	75.58	3	121.15	1/8	166.60	5/8	217.00
3/4	30.25	3/8	55.45	1 15/16	78.20	1/8	126.21	1/4	171.76	1/2	222.05
13/16	32.75	7/16	58.04	2	80.75	1/4	131.26	3/8	176.71	3/8	227.01
7/8	35.26	1/2	60.52	1/8	85.75	3/8	136.32	1/2	181.77	3/4	232.15
15/16	37.75	9/16	63.05	1/4	90.81	1/2	141.37	5/8	186.79	7/8	237.20
-----	40.35	5/8	65.56	3/8	95.86	5/8	146.41	3/4	191.84	6	242.25
1/16	42.87	11/16	68.11	1/2	100.90	3/4	151.46	7/8	196.90	-----	--------
1/8	45.40	4	--------	5/8	105.95	-----	--------	5	201.85	-----	--------

For steel plates, multiply tabular number above (for size) by 1.01.

TABLE NO. 10.

Flow of Water through Clean Iron Pipes per Second.

Fall per Mile.	Fall per Rod.		Diameters.					
Feet.	Feet.	Inches.	½ Inch. Cu. ft.	¾ Inch. Cu. ft.	1 Inch. Cu. ft.	1½ Inch. Cu. ft.	1¾ Inch. Cu. ft.	2 Inches. Cu. ft.
21.12	0	0.792	--------	--------	--------	--------	--------	.02584
26.40	0	0.990	--------	--------	--------	--------	.02014	.02924
31.68	0	1.188	--------	--------	--------	.01460	.02270	.03274
36.96	0	1.396	--------	--------	--------	.01583	.02426	.03492
42.24	0	1.584	--------	--------	.00567	.01707	.02638	.03776
47.52	0	1.782	--------	--------	.00617	.01816	.02838	.04081
52.80	0	1.980	--------	.00316	.00677	.01963	.02988	.04321
63.36	0	2.376	.00122	.00350	.00781	.02133	.03260	.04843
73.92	0	2.772	.00124	.00377	.00841	.02282	.03556	.05150
84.48	0	3.168	.00135	.00411	.00886	.02466	.03706	.05456
95.04	0	3.564	.00143	.00445	.00961	.02577	.03923	.05740
105.60	0	3.960	.00150	.00466	.00990	.02793	.04224	.06111
158.40	0	5.940	.00197	.00589	.01245	.03458	.05175	.07399
211.20	0	7.920	.00241	.00705	.01492	.04132	.06167	.08734
264.00	0	9.900	.00279	.00798	.01666	.04577	.07145	.1095
316.80	0	11.880	.00315	.00874	.01857	.05043	.07830	.1200
369.60	1	1.86	.00340	.00951	.01988	.05424	.08381	.1288
422.40	1	3.84	.00366	.01012	.02141	.05804	.08949	.1375
475.20	1	5.82	.00389	.01086	.02283	.06191	.09400	.1442
528.00	1	7.80	.00410	.01144	.02424	.06724	.10030	.1523
633.00	1	11.76	.00453	.01282	.02676	.07400	.1110	.1634
739.20	2	3.72	.00473	.01380	.02890	.08020	.1200	.1748
844.00	2	7.68	.00524	.01480	.03081	.08622	.1285	.1855
950.40	2	11.64	.00559	.01567	.03276	.09225	.1372	.1955
1056.00	3	3.60	.00589	.01656	.03458	.09692	.1450	.2047
1320.00	4	1.50	.00660	.01871	.03897	.1079	.1617	.2276
1584.00	4	11.40	.00732	.02064	.04316	.1187	.1773	.2483
2112.00	6	7.20	.00855	.02390	.04987	.1380	.2050	.2833
2640.00	8	3.00	.00966	.02705	.05648	.1550	--------	--------
3168.00	9	10.80	.01065	.03003	.06320	--------	--------	--------
3696.00	11	6.60	.01156	.03301	.06943	--------	--------	--------
4224.00	13	2.40	.01248	.03572	--------	--------	--------	--------
4752.00	14	10.20	.01338	.03786	--------	--------	--------	--------
5280.00	16	5.00	.01419	--------	--------	--------	--------	--------

TABLE No. 10—Continued.

Flow of Water through Clean Iron Pipes per Second.

Fall per Mile.	Fall per Rod.		Diameters.						
Feet.	Feet.	Inches.	3 Inches. Cu. ft.	4 Inches. Cu. ft.	6 Inches. Cu. ft.	8 Inches. Cu. ft.	10 Inches. Cu. ft.	11 Inches. Cu. ft.	12 Inches. Cu. ft.
5.280	0	0.198	--------	--------	--------	--------	--------	--------	1.265
6.336	0	0.238	--------	--------	--------	--------	.878	1.120	1.402
7.392	0	0.277	--------	--------	--------	--------	.960	1.221	1.489
8.448	0	0.317	--------	--------	--------	.573	1.047	1.320	1.634
9.504	0	0.356	--------	--------	--------	.611	1.110	1.394	1.728
10.560	0	0.396	--------	--------	.298	.639	1.194	1.490	1.826
11.616	0	0.436	--------	--------	.314	.659	1.265	1.580	1.940
12.672	0	0.475	--------	--------	.330	.703	1.325	1.653	2.026
13.728	0	0.515	--------	.1235	.346	.737	1.377	1.722	2.117
14.784	0	0.554	--------	.1298	.359	.768	1.423	1.788	2.207
15.840	0	0.594	.0630	.1335	.377	.808	1.470	1.854	2.297
18.480	0	0.684	.0692	.1465	.395	.876	1.587	1.996	2.466
21.120	0	0.792	.0749	.1562	.444	.931	1.683	2.136	2.662
26.400	0	0.990	.0839	.1771	.496	1.045	1.865	2.397	3.020
31.680	0	1.188	.0915	.1923	.548	1.157	2.059	2.636	3.310
36.960	0	1.386	.0992	.2146	.589	1.262	2.222	2.858	3.601
42.240	0	1.584	.1060	.2339	.631	1.344	2.383	3.062	3.856
47.520	0	1.782	.1119	.2460	.672	1.424	2.514	3.232	4.072
52.800	0	1.980	.1190	.2582	.721	1.496	2.662	3.419	4.305
63.360	0	2.376	.1313	.2893	.784	1.644	2.932	3.760	4.728
73.920	0	2.772	.1413	.3036	.858	1.782	3.210	4.016	5.094
84.480	0	3.168	.1507	.3237	.922	1.916	3.450	4.390	5.482
95.040	0	3.564	.1590	.3412	.975	2.033	3.679	4.679	5.839
105.600	0	3.960	.1717	.3607	1.022	2.155	3.856	5.251	6.160
158.400	0	5.940	.2081	.4502	1.263	2.667	4.762	6.086	7.630
211.200	0	7.920	.2469	.5331	1.484	3.145	5.563	7.022	8.860
264.000	0	9.900	.2785	.5954	1.665	3.513	6.704	8.244	9.967
316.800	0	11.880	.3049	.6390	1.929	3.847	--------	--------	--------
369.000	1	1.860	.3331	.6967	1.976	4.196	--------	--------	--------
422.400	1	3.84	.3559	.7506	2.144	--------	--------	--------	--------
475.200	1	5.820	.3816	.7960	2.274	--------	--------	--------	--------
528.000	1	7.800	.4043	.8467	2.399	--------	--------	--------	--------
633.600	1	11.760	.4440	.9270	--------	--------	--------	--------	--------
739.200	2	3.720	.4977	1.0060	--------	--------	--------	--------	--------
844.800	2	7.680	.5131	1.0810	--------	--------	--------	--------	--------
950.400	2	11.640	.5436	--------	--------	--------	--------	--------	--------
1056.000	3	3.600	.5832	--------	--------	--------	--------	--------	--------
1320.000	4	1.500	.6523	--------	--------	--------	--------	--------	--------
1584.000	4	11.400	--------	--------	--------	--------	--------	--------	--------

TABLE No. 10—Continued.

Flow of Water through Clean Iron Pipes per Second.

FALL PER MILE.	FALL PER ROD.	DIAMETERS.							
Feet.	Ft. In.	14 Inches. Cu. ft.	15 Inches. Cu. ft.	16 Inches. Cu. ft.	18 Inches. Cu. ft.	20 Inches. Cu. ft.	22 Inches. Cu. ft.	24 Inches. Cu. ft.	27 Inches. Cu. ft.
2.11	0 0.08	--------	--------	--------	--------	--------	--------	--------	--------
2.64	0 0.10	--------	--------	--------	--------	--------	--------	--------	8.27
3.17	0 0.12	--------	--------	--------	--------	3.61	4.61	6.10	8.37
3.70	0 0.14	--------	--------	2.25	3.10	4.07	5.25	6.64	9.09
4.22	0 0.16	1.71	2.05	2.43	3.27	4.35	5.62	7.13	9.48
4.75	0 0.18	1.83	2.19	2.59	3.49	4.68	6.01	7.56	10.26
5.28	0 0.20	1.91	2.30	2.72	3.66	4.92	6.32	7.95	10.74
5.81	0 0.22	2.02	2.43	2.88	3.88	5.15	6.62	8.34	11.45
6.34	0 0.24	2.11	2.54	3.02	4.06	5.40	6.94	8.75	11.93
6.86	0 0.26	2.18	2.65	3.18	4.23	5.62	7.24	9.14	12.54
7.39	0 0.28	2.27	2.75	3.28	4.40	5.82	7.51	9.47	12.96
7.92	0 0.30	2.35	2.84	3.39	4.61	6.05	7.78	9.80	13.49
8.45	0 0.32	2.44	2.94	3.49	4.75	6.27	8.05	10.13	13.98
8.98	0 0.34	2.54	2.98	3.62	4.90	6.48	8.36	10.57	14.41
9.50	0 0.36	2.59	3.11	3.69	5.03	6.65	8.55	10.77	14.81
10.03	0 0.38	2.67	3.21	3.81	5.17	6.92	8.85	11.10	15.21
10.56	0 0.40	2.72	3.29	3.92	5.30	7.05	9.07	11.43	15.63
11.62	0 0.44	2.88	3.47	4.12	5.63	7.42	9.55	12.05	16.44
12.67	0 0.48	3.02	3.63	4.32	5.87	7.79	10.01	12.61	17.23
13.73	0 0.51	3.15	3.79	4.51	6.18	8.14	10.48	13.23	18.01
14.78	0 0.55	3.29	3.95	4.68	6.38	8.48	10.91	13.79	18.75
15.84	0 0.59	3.42	4.11	4.87	6.64	8.77	11.29	14 25	19.50
18.48	0 0.69	3.62	4.46	5.31	7.17	9.49	12.25	15.50	21.13
21.12	0 0.79	3.99	4.78	5.67	7.65	10.16	13.12	16.62	22.62
26.40	0 0.99	4.46	5.37	6.39	8.66	11.43	14.78	18.71	25.34
31.68	0 1.19	4.91	5.91	7.02	9.54	12.59	16.20	20.42	27.74
36.96	0 1.39	5.37	6.45	7.66	10.33	13.66	17.53	22.05	29.96
42.24	0 1.59	5.77	6.90	8.16	11.09	14.66	18.78	23.61	31.99
47.52	0 1.78	6.11	7.31	8.64	11.71	15.54	19.93	25.07	33.97
52.80	0 1.98	6.44	7.70	9.10	12.37	16.47	21.06	26.42	35.89
63.36	0 2.38	7.00	8.39	9.95	13.65	17.99	23.97	29.03	39.76
73.92	0 2.77	7.60	9.15	10.87	14.75	19.49	24.68	31.49	43.22
84.48	0 3.17	8.17	9.81	11.63	15.84	21.03	26.97	33.90	46.57
95.04	0 3.56	8.93	10.47	12.43	16.90	22.45	29.70	36.18	48.06
105.60	0 3.96	9.26	11.09	13.14	17.85	23.56	31.15	38.45	--------
158.40	0 5.94	11.39	13.66	16.17	21.86	28.86	--------	--------	--------
211.20	0 7.92	13.22	15.84	18.77	--------	--------	--------	--------	--------

TABLE No. 10—Continued.

Flow of Water through Clean Iron Pipes per Second.

FALL PER MILE.	FALL PER ROD.		DIAMETERS.					
Feet.	Feet.	Inches.	30 Inches. Cu. ft.	33 Inches. Cu. ft.	36 Inches. Cu. ft.	40 Inches. Cu. ft.	44 Inches. Cu. ft.	48 Inches. Cu. ft.
1.06	0	0.04	--------	--------	10.29	13.88	18.15	22.98
1.58	0	0.06	7.78	10.21	12.70	17.00	22.22	27.89
2.11	0	0.08	8.99	11.65	14.56	19.68	25.55	32.93
2.64	0	0.10	10.24	12.92	16.35	22.08	28.87	37.00
3.17	0	0.12	10.97	13.99	18.02	24.43	31.46	40.21
3.70	0	0.14	11.90	15.14	19.76	26.27	34.47	43.67
4.22	0	0.16	12.84	16.36	20.85	28.14	37.05	46.84
4.75	0	0.18	13.48	17.58	22.30	29.80	39.01	49.06
5.28	0	0.20	14.21	18.74	23.47	31.46	41.06	52.15
5.81	0	0.22	15.05	19.54	24.91	33.25	42.09	54.95
6.34	0	0.24	15.81	20.28	26.12	34.68	44.97	57.36
6.86	0	0.26	16.47	21.29	27.20	36.21	46.77	60.07
7.39	0	0.28	17.18	22.20	28.24	37.57	48.83	62.02
7.92	0	0.30	17.94	23.01	29.19	39.18	50.62	64.47
8.45	0	0.32	18.58	23.76	30.29	40.51	52.46	66.53
8.98	0	0.34	19.21	24.47	31.42	41.88	54.04	68.50
9.50	0	0.36	19.66	25.22	32.48	43.07	55.48	70.62
10.03	0	0.38	20.32	26.14	33.40	44.28	57.01	72.75
10.56	0	0.40	20.79	26.94	34.49	45.20	58.85	74.44
11.62	0	0.44	21.80	28.27	36.15	48.12	61.71	78.29
12.67	0	0.48	22.83	29.02	37.74	50.48	64.35	81.68
13.73	0	0.51	23.93	31.06	39.40	52.67	66.87	85.20
14.78	0	0.55	24.86	32.28	40.86	55.04	69.57	88.46
15.84	0	0.59	25.87	33.62	42.28	56.33	72.32	91.73
18.48	0	0.69	27.96	36.17	45.95	61.09	77.95	100.40
21.12	0	0.79	29.84	38.57	48.83	65.41	83.60	105.89
26.40	0	0.99	33.55	43.12	54.89	73.09	93.37	119.34
31.68	0	1.19	36.79	47.40	59.95	80.32	103.28	130.88
36.96	0	1.39	39.66	51.35	65.17	86.70	111.74	142.09
42.24	0	1.59	42.39	54.91	69.80	92.58	119.93	153.94
47.52	0	1.78	45.23	58.20	74.33	98.00	128.26	--------
52.80	0	1.98	47.71	61.62	78.46	103.99	--------	--------
63.36	0	2.38	52.91	68.00	82.84	--------	--------	--------
73.92	0	2.77	57.65	73.95	--------	--------	--------	--------

TABLE No. 10—Continued.

Flow of Water through Clean Iron Pipes per Second.

FALL PER MILE.	FALL PER ROD.		DIAMETERS.				
Feet.	Feet.	Inches.	54 Inches. Cu. ft.	60 Inches. Cu. ft.	72 Inches. Cu. ft.	84 Inches. Cu. ft.	96 Inches. Cu. ft.
.53	0	0.02	21.96	29.77	46.99	75.43	107.77
1.06	0	0.04	31.70	38.19	57.65	104.61	152.45
1.58	0	0.06	38.53	52.09	82.53	126.18	188.45
2.11	0	0.08	45.12	59.04	95.99	145.43	218.75
2.64	0	0.10	50.23	67.56	109.42	162.75	245.30
3.17	0	0.12	55.51	74.32	121.58	177.03	267.41
3.70	0	0.14	60.61	80.51	132.04	192.04	290.53
4.22	0	0.16	63.61	86.30	139.96	207.81	310.89
4.75	0	0.18	67.20	91.99	148.72	222.44	324.20
5.28	0	0.20	72.37	96.98	157.77	235.13	350.45
5.81	0	0.22	75.71	102.39	165.97	253.34	366.19
6.34	0	0.24	79.13	107.31	173.04	264.77	382.02
6.86	0	0.26	82.54	115.53	179.26	275.16	397.85
7.39	0	0.28	85.90	116.53	187.46	287.67	414.70
7.92	0	0.30	89.52	119.68	193.93	296.37	427.76
8.45	0	0.32	92.47	123.70	200.18	307.87	443.09
8.98	0	0.34	95.35	127.63	206.40	316.15	457.42
9.50	0	0.36	97.65	131.26	212.05	326.73	470.49
10.03	0	0.38	100.19	134.79	217.71	335.79	481.53
10.56	0	0.40	103.82	138.84	225.21	348.25	496.37
11.62	0	0.44	108.78	145.98	235.52	364.92	522.76
12.67	0	0.48	113.47	152.56	246.41	389.09	547.38
13.73	0	0.51	118.48	158.65	256.17	394.43	570.01
14.78	0	0.55	123.10	164.54	267.19	408.36	592.13
15.84	0	0.59	128.19	170.43	277.88	423.36	612.00
18.48	0	0.69	138.92	183.98	299.72	462.99	----------
21.12	0	0.79	147.91	197.52	320.74	----------	----------
26.40	0	0.99	165.80	221.95	358.52	----------	----------
31.68	0	1.19	182.42	244.26	----------	----------	----------
36.96	0	1.39	190.01	----------	----------	----------	----------

TO DETERMINE THE FLOW OF WATER THROUGH IRON PIPES.

For this purpose the total head is divided into three parts, viz.: First, that portion of the head due to the velocity; second, that portion which overcomes the resistance of entry; and third, that portion which overcomes the resistance within the pipe. In long pipes, the two former portions as compared with the latter portion of the total head, are quite small. In Table No. 10, herein referred to, the greatest velocity in any pipe is 13.445 feet per second, due to 4.2 feet, the sum of the first and second portions of the total head, while the third portion of the head is 211.2 feet. The head in the table referred to, refers to the third portion of the total head or the resistance of the water within the pipe. The computation is based upon the assumption that the length of any given pipe is not less than 1,000 times its diameter.

The fall being 52.8-10 feet per mile, what will be the flow through a pipe twenty inches in diameter, in cubic feet and also in miner's inches?

In Table No. 10, find in the first column 52.8 feet, opposite which in the column headed twenty inches, is found the quantity discharged, viz.: 16.47 cubic feet, which multiplied by fifty, will give 823.50 miner's inches.

The diameter of a pipe being twenty inches, what fall or head will be required for the pipe to carry 1,000 inches?

In Table No. 10, in column headed twenty inches, find the nearest number which, multiplied by fifty, will give the required number, 1,000 inches. The nearest number is 19.49, opposite which, in column headed "Fall per mile," will be found 73.92, the fall or head required.

What will be the effective head at the mine, of 1,000 inches of water carried in a pipe twenty inches in diameter, and having a fall of one hundred feet to the mile?

In Table No. 10, in column headed twenty inches diameter of pipe, find the number which, multiplied by fifty, will make (approximately) 1,000 inches; and to find 19.49 cubic feet opposite which, in column headed "Fall per mile," we find 73.92, which is the head per mile lost in carrying the given water. Subtracting this from the given head or fall, and we have the effective head or 100-73.92=26.08 feet.

There being 7-8.10 gallons of water in a cubic foot, and 86.400 seconds in a day (24 hours) and the fall 52.8-10 feet per mile, how many gallons will a pipe ten inches in diameter carry per day?

In Table No. 10, in column headed ten inches (diameter of pipe) and opposite 52.8 fall per mile, is found 2.662 cubic feet flow per second; we then have $2.662 \times 7.8 \times 86.400 = 1,793,975$ gallons.

GENERAL RULE.—The velocity per second is equal to fifty times the square root of the product of the head and diameter of pipe in feet, divided by the sum of the length and fifty times the diameter of the pipe (in feet). This rule is for either short or long pipes, and is sufficiently accurate when the diameter of the pipe does not exceed two feet.

SIGNALS.

The pipeman communicates his desire to have the water turned on or off at the head, to the watchman in charge, by signals. At the Polar Star mine, at Dutch Flat, the signals are made by changing the color of a board, thirty by forty inches, painted white, over which a similar board slips up and down. The motion is communicated by a wire which leads to a convenient point near the giant. The movable board is painted red. The signal is placed in a prominent position, within full sight of the pressure box. When the wire is pulled the red board rises and covers the white, and the watchman at the head sees only the red, which implies "turn on the water." When the wire is slackened the red board sinks down out of sight, and the white signal commands the water to be shut off. These signals can be seen with perfect distinctness, and the signaled order is immediately obeyed. These signals are of the greatest importance, as great injury might result to the pipes from inattention. The man at the head must be particularly trustworthy, reliable, prompt, and active. All the time that piping is going on, this man must be at his post. Other miners use other signals, but this system seemed to me to fill all the requirements of a convenient and reliable signal.

NOZZLE, OR HYDRAULIC MACHINE.

At the termination of the iron pipe line, water is projected against the gravel bank in a continuous stream, passing through a hydraulic nozzle, or hydraulic machine, as it is sometimes called. The nozzles in use are of different models and make, but the one now most generally in use is the "little giant," or giant, as it is generally called, invented by Richard Hoskin. This improved nozzle, provided with the Perkins deflector, seems to be very nearly perfection, and for some years no material improvement has been desired or proposed.

The water flows through the giant with a force proportional to the elevation of the pressure box. To those who have never seen a stream of 1,500 inches under a pressure of from 400 to 500 feet, flowing through an eight or nine-inch nozzle, it will be impossible to realize the force with which this shaft of water strikes the gravel bank at a distance of several hundred feet, or the effect of the continual bombardment of the swift rushing stream. Under a pressure of 300 feet, through a six-inch nozzle, a hydraulic stream moves at the rate of 140 feet per second, and in a volume weighing 1,650 pounds. During this short period of time the force of the impact is one tenth that produced by a cannon ball. Before the jet, the partly indurated gravel seems to melt away and move with the water—the back-flow of which, after the force of the impact is exhausted, carries with it and washes down soft mud, small gravel, and bowlders of considerable size, through the bedrock cuts, tunnels, sluices, etc., still to be described, in a continual stream, as long as the piping continues.

The nozzle is under perfect control, and can be guided, notwithstanding its terrible power, by the hand of a child. To stand beside one of these gigantic fountains, and to direct the stream by the movement of a small lever, is to experience a strange sensation, and to realize the power of mind over matter. If a hydraulic stream should by accident strike a man, he would be killed as surely and as quickly as if struck by the engine of a flying railway train.

As the water rushes from the nozzle it seems as hard as the iron of the nozzle itself. If struck with an iron crowbar, no impression seems to be made upon it. It sometimes, but very rarely, happens in the experience of hydraulic mining, that a giant becomes disconnected from the pipe by some accident; in which case a sudden burst of water takes place, followed by a collapse of the iron pipes; and it is not considered a proof of cowardice at such a moment on the part of the pipeman in attendance to run away.

The hydraulic nozzle, like the other appliances of hydraulic mining now in use, has reached its present state of perfection by progressive steps. The first nozzle was a pipe of tin plate, tapering gradually in size from the flexible hose down to an inch to two inches in diameter. The next step was a cast brass pipe, four or five inches at the butt; and connecting with the hose by a screw joint. This pipe was too heavy to hold in position by hand, and was placed in a sort of tripod while in operation. The gooseneck, which followed the straight brass pipe, was modeled after the discharge pipe used with the old-fashioned hand fire-engine. It was, practically, a flexible iron joint, formed of two elbows working one over the other, with a coupling joint between them.

This pipe, however, had some serious defects. The abrupt turn of the elbow broke the force of the water very considerably; the upward pressure caused the joint to move hard, and when the pipe was turned horizontally the reaction would cause the pipe to "buck" or fly around in a contrary direction. The same reaction often occurred in elevating or depressing the pipe. While the gooseneck was an undoubted improvement, its defects were so great that it was soon followed by the Craig Globe Monitor, invented by R. R. and J. Craig, of Nevada City. The description is from the Mining and Scientific Press of October 1, 1870:

The Messrs. Craig have been engaged for the last three years in perfecting this invention, and their efforts have resulted in the production of an apparatus for hydraulic mining that, after a thorough trial, in over a hundred of the most extensive and prominent mines of the State, has received the highest recommendations of experienced miners. The invention consists of a hollow globe or reservoir in which fits a ball or socket cut open on top. The ball revolves round horizontally, and up and down at an angle of about forty degrees. This play has been found amply sufficient for all ordinary mining purposes, and the water being fed to the discharge pipe from the globe, or reservoir, has not the bad effect caused by a short turn in the pipe, like that produced by a common elbow, but causes a perfect stream to emerge, from which the nozzle may be directed. As a matter of economy, it not only places the water of seven or eight ordinary hose pipes under the control of one man, but its durability is so great (one lasting a lifetime), that its extra first-cost is seldom noticed, it being in convenience alone worth more to the miner than the difference in cost of canvas hose. No canvas being used, it is not liable to break under heavy pressure, and saves the annual outlay for canvas, while the concentration of a larger body in one column has been found to do nearly treble the amount of execution in comparison with ordinary expenses.

Notwithstanding the great advantages of the Craig nozzle, it soon gave way to the "Hydraulic Chief," invented by Mr. F. H. Fisher, of Nevada County, California, sometimes known as the "Knuckle-joint and Nozzle. The distinctive feature of this nozzle consists of a double set of elbows, placed in a reversed position when in line, but allowed to revolve on a series of friction rollers. The upper elbow has a free horizontal movement, while the knuckle-joint attached to the apparatus permits a vertical motion. The entire machine is, practically, a universal joint. The pipe man, standing at the end of the lever, could direct the stream in any direction. The inside construction is such that there is but little friction for the water to overcome, there being no bolts or other fastenings to obstruct the stream. An important feature in the Fisher nozzle was the fact that it could be used without personal danger, which had been great during the use of the former pipe nozzles. The following description is by Joshua Hendy, of San Francisco:

This machine consists of two elbows, placed in reversed position when standing in right line, but made to revolve by a ring in which there is a series of anti-friction rolls, the ring being slipped down over the top of the lower elbow, and there held in its place by a flange bolted to the top of the lower elbow. The ring is then bolted to a flange on the top elbow, thereby connecting the two, and at the same time leaving the top elbow free to move around in a complete circle. When the water is let into the elbow the pressure brings the rolls in the ring up against the flange on top of the bottom elbow, allowing the top elbow to move around easily and without any friction, except that of the rolls themselves. In the outlet on top elbow is a knuckle-joint, which permits the up and down motion of the discharge pipe. It is a concave surface fitted to a convex one; the concave has an opening for the pipe to pass through.

The machine is operated by a lever with two arms, and attached to the top elbow by trunnions. This lever is so arranged that an up and down motion is imparted to the discharge pipe, and as well a lateral horizontal motion to the whole machine, except the bottom elbow. The pipe stands firmly in place when the water is on; the operator standing at the end of the lever can easily direct the stream to any point, good execution being done at long distances from the bank, thereby securing safety from caves.

To prevent a rotary motion of the water, produced when the elbows are turned different ways, vanes or rifles are inserted in the discharge pipe. These vanes force the water to issue in a straight line from the discharge pipe, and thus prevent the scattering of the stream, on the solid and columnar shape of which so much of its effectiveness depends.

Next followed what was known as the "Hoskins Dictator," in which the pressure exerted by the water tends to force the joints apart. An elastic packing between them prevents leakage. The vertical movement is here effected by means of pivots and the horizontal by means of wheels, though open to the objections charged to the gooseneck, this machine still continues to be used to a limited extent, being simple in its construction and little liable to get out of repair.

The little giant nozzle, before mentioned, is a still more recent improvement by the inventor on the dictator, and has to a great extent superseded the older inventions. Before the advent of the deflector, the giant was controlled by a long lever, by means of which it was directed as desired, but the work was difficult and laborious. The deflector has done away with all the former clumsy devices for directing the stream.

The following description is furnished by Richard Hoskins, the inventor, and affords all additional information required for a perfect understanding of the machine:

Marysville, January 26, 1882.

H. G. Hanks, Esq.: Dear Sir.—As near as I can get it, the straight pipe was used at a very early day. At first ground sluicing was practiced, and tolerably deep banks were washed down. It was often found to be impossible to get the water to run just where it was wanted. This led to the use of hose of canvas, which could be laid as wished, and the water discharged where wanted, or generally so; but sometimes even this could not be done, and the miner would take the end of the hose in his hands, pucker it up, the water would then back up and gain head, and he was enabled to squirt it where before he could not reach. The next step was to bore a hole in a plug and insert the plug in the end of the hose and tie it there. This was found to be a great improvement. Next came a tin pipe in place of a plug, and then the copper pipe with brass nozzles, etc. As "necessity is the mother of invention," these seem to be the successive steps which were adopted in different places, and, probably, without one party knowing what any other party was doing.

Hose, ere long, was superseded by iron pipe, at first about the same diameter as hose, but when it was demonstrated that it was more profitable to use larger heads of water and to concentrate it, and heavier pressure also began to be used, and as hose even a short section of the size necessary to the purpose, when full, was too rigid to manipulate, metallic flexible joints became a necessity, and this stimulated invention, resulting in many machines of divers patterns, most of which did not go beyond the domain of experiment. The machine known as the "gooseneck," was extensively used in Nevada County, and some few in other parts.

This machine had a horizontal joint and a short section of hose between the top elbow and discharge pipe, which, when filled, was sufficiently flexible to allow of elevation and depression. It was liable to "buck" in the hands of a novice, thus: Suppose he attempted to push the pipe from him, when he got a sufficient bend in the hose—the back joint being a little hard to move—the water, impinging on the angle formed, would suddenly throw the pipe back the reverse way, often knocking over the operator. With the increase in the quantity of water used, larger machines were needed, and large hose was not flexible enough, and would, by constant use, soon be worn out. To meet the requirement Mr. Craig got up the "monitor." This was simply a ball and socket joint. It was exceedingly hard to work, often taking four or five men to manipulate it.

Mr. Craig then invented and patented the interior tripod and belt. This was a tripod with a center having a hole to take a bolt with a knob on the end; the other end passed out through the top of elbow and had a nut with lever. By tightening this nut it threw the strain on the bolt and reduced the friction on the joint proper. Many of these machines were used, but they were defective in form, and, at best, hard to work and soon got leaky at joint.

The next machine introduced was Fisher's Knuckle-joint. This was a two-jointed machine, like the Allenwood, for in it the section of canvas hose answered the purpose of a joint, but the joints were differently constructed. The upper joint, like the Craig, was formed by contact of metallic faces, and, like the Craig, rapidly became impaired and leaky, and was expensive to keep in order. Many of these machines were used, some of them quite large in size.

In July 19, 1870, Hoskin got a patent for his "dictator," which he had invented some few months previously. This was a one-jointed machine, having an elastic packing in the joint instead of two metallic faces. This joint worked up and down on the pivots, and in rotating it the wheels ran around up against the flange. Many of these were used, but all of small size, not over seven inches inlet. Soon after, Hoskin got up the "little giant," a two-jointed machine. These, from their simplicity and durability, rapidly superseded all others. From their peculiar shape, they offered less obstruction to the flow of water, and hence better results.

Giants are now used the world over, where hydraulic mining is practiced, all other machines having been discarded.

The next great improvement in hydraulic mining apparatus was the "deflector," patented by Mr. Perkins in May, 1876. This consists of a short piece of pipe about an inch larger in diameter than the nozzle, and attached to the end of the nozzle by a gimbal joint, and operated by a lever. Each size nozzle requires a separate deflector.

This was soon followed by the invention of Hoskin's Deflector. This, instead of being a separate pipe attached to the end of the nozzle, is a flexible semi-ball joint between the end of the discharge pipe and nozzle, the nozzle screwing to it. Patented December 12, 1876. It is also operated by means of a lever. The same deflector serves for any size of nozzle of less caliber than the nozzle built. This is the deflector almost universally used, or at least seventy-five per cent. used are Hoskin's.

The mode of operation is somewhat different, but the result the same. Hoskin, by means of a flexible packed joint, makes an angle in the pipe itself. Perkins has a piece which surrounds the stream, but, when going straight forward, does not touch it. This he bends until it is struck at an angle by the stream, and throws the pipe around.

CASH PRICES OF GIANTS,

Including two Nozzles for each Machine.

Number.	Inlet.	Outlet.	Weight, about—	Diamond Nozzle Butt, inside.	Price.
Number one	7	5½	245 lbs.	4 inches.	$125 00
Number two	9	7	450 lbs.	5 inches.	175 00
Number three	11	7½	665 lbs.	5 or 6 inches.	225 00
Number four	11	9½	750 lbs.	7 inches.	250 00
Number five	15	9½	875 lbs.	8 inches.	300 00
Number six	15	11	1,050 lbs.	9 inches.	325 00

The deflector, or Perkins nozzle, is the invention of Henry C. Perkins, the Superintendent of the North Bloomfield Gravel Mining

Company, of Nevada County, California, but the idea is the result of accident. Mr. David Stokes, foreman of the mine, was one day washing a shovel in the stream of a giant of the old style, when he noticed that the giant was swerved in a direction opposite to the position of the shovel. He called the attention of Mr. Perkins to the action of the giant, when the two gentlemen made further experiments, which led to the discovery of the fact that the blade of the shovel held against the stream would cause the giant to move slowly in an opposite direction, upon which they fixed paddles on either side, independent of each other. The paddles, or blades, terminated in strong levers, by the aid of which a horizontal motion was given to the giant. The vertical motion was still imparted by the long steering lever already described. This beginning led to the present perfect deflector.

The following directions for setting the giant is also furnished by Mr. Hoskin:

In setting giants, secure as thoroughly as is thought necessary; it is always better to stake against the bed piece and brace against the stakes, than to brace directly against the bed piece. There should be a hole in each end of the bed piece, and an iron bar driven through it into the ground. Lubricate often both joints, and under the nut of main bolt of giant; also the ball of the deflector, which can be reached through the nozzle. Tallow is better than oil, as the latter is too thin; when the water is very cold, axle grease perhaps is best as it will not crumble.

When a stream of water under pressure emerges from a smooth pipe and nozzle it does so with a rotary motion, which causes it to spread out into an irregular stream not so effective as the smooth shaft sent forth by the improved nozzle of the present day. This was early noticed, and to overcome the difficulty the rifled nozzle was invented in 1863 by Macy & Martin, of Red Dog, Nevada County. This improvement is now applied to all hydraulic nozzles, and is considered an indispensable addition. The rifling consists of radial plates of thin iron, which have exactly the contrary effect of the rifling in a gun, for which reason the term as applied to the hydraulic nozzle is a misnomer. The radial plates overcome the tendency of the water to rotate and cause it to rush forth in a smooth and compact stream.

The average sized nozzle used at the principal hydraulic mines of the State is seven inches. The following table gives the pressure, size of nozzle, and size of pipe, at several of the principal deep placer mines of the State, which may be taken as a type of the others:

Name.	Pressure—Feet.	Nozzle.	Pipe at Giant.
Polar Star, Placer County	400	7 inches.	14 inches.
North Bloomfield, Nevada County	175,180,225,307	8, 9 inches.	15 inches.
Bonanza, Gold Run, Placer County	475	7¾ inches.	16 inches.
American Twin, Nevada County	-------	7⅝ inches.	15 inches.
Milton, Nevada County	439	-------	-------

Tables giving the flow of water through nozzles furnished by Joshua Hendy, San Francisco:

TABLE NO. 11.

Flow of Water through Nozzles—Quantity and Horse-power.

Head.	Velocity per second.	50 M. inch. 1 cu. ft.	100 M. inch. 2 cu. ft.	Diameters of Nozzles.							
				1 inch.		1.5 inches.		2 inches.		2.5 inches.	
Feet.	Feet.	H. P.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.
1.0	8.025	.106	.212	.041	.0046	.093	.010	.164	.018	.255	.029
1.5	9.83	.158	.316	.050	.0085	.111	.019	.200	.034	.312	.053
2.0	11.35	.211	.422	.058	.013	.130	.029	.232	.052	.360	.082
2.5	12.68	.264	.528	.064	.018	.145	.041	.256	.072	.402	.114
3.0	13.90	.317	.634	.061	.024	.159	.054	.284	.096	.440	.150
3.5	15.01	.370	.740	.076	.030	.171	.068	.304	.120	.475	.189
4.0	16.05	.421	.842	.081	.037	.183	.083	.324	.148	.507	.231
4.5	17.02	.474	.948	.086	.044	.194	.099	.344	.176	.540	.275
5.0	17.95	.528	1.06	.091	.051	.205	.113	.364	.204	.567	.315
6.0	19.66	.634	1.27	.100	.068	.224	.153	.400	.272	.622	.425
7.0	21.23	.739	1.48	.108	.086	.242	.193	.432	.344	.672	.535
7.5	21.98	.702	1.58	.111	.095	.250	.214	.444	.380	.697	.595
10.0	25.38	1.06	2.12	.129	.146	.290	.329	.516	.584	.805	.915
12.5	28.37	1.32	2.64	.144	.204	.324	.460	.576	.816	.897	1.28
15.0	31.08	1.59	3.18	.158	.269	.355	.505	.632	1.08	.985	1.68
17.5	33.57	1.85	3.70	.170	.339	.383	.782	.680	1.36	1.06	2.11
20.0	35.89	2.11	4.22	.182	.414	.410	.931	.728	1.66	1.14	2.58
22.5	38.07	2.38	4.76	.193	.494	.435	1.11	.772	1.98	1.21	3.08
25.0	40.13	2.64	5.28	.204	.578	.458	1.30	.816	2.31	1.27	3.61
27.5	42.08	2.90	5.80	.213	.667	.480	1.50	.852	2.67	1.33	4.17
30.0	43.95	3.02	6.04	.228	.760	.513	1.71	.912	3.04	1.42	4.75
32.5	45.75	3.34	6.68	.232	.857	.522	1.93	.928	3.43	1.45	5.35
35.0	47.47	3.69	7.38	.241	.958	.542	2.15	.964	3.83	1.51	5.98
40.0	50.75	4.22	8.44	.257	1.17	.579	2.63	1.03	4.68	1.61	7.31
45.0	53.83	4.75	9.50	.273	1.40	.614	3.14	1.09	5.60	1.71	8.23
50.0	56.75	5.28	10.56	.288	1.64	.648	3.68	1.15	6.56	1.79	10.22
60.0	62.16	6.34	12.68	.385	2.15	.709	4.84	1.26	8.60	1.97	13.43
70.0	67.14	7.39	14.78	.341	2.71	.766	6.10	1.36	10.84	2.13	16.93
80.0	71.78	8.46	16.90	.364	3.31	.819	7.45	1.46	13.24	2.27	20.69
90.0	76.13	9.53	19.06	.386	3.95	.864	8.88	1.54	15.80	2.44	24.68
100.0	80.25	10.56	21.12	.407	4.63	.916	10.41	1.63	18.52	2.54	28.90
125.0	89.72	13.21	26.42	.455	6.47	1.02	14.55	1.82	25.88	2.84	40.40
150.0	98.28	15.85	31.70	.499	8.50	1.12	19.12	2.00	34.00	3.11	53.12
175.0	106.1	18.50	37.00	.539	10.70	1.21	24.07	2.16	42.80	3.36	66.86
200.0	113.5	21.14	42.28	.576	13.1	1.29	29.43	2.30	52.4	3.59	81.75
250.0	127.1	26.42	52.84	.644	18.3	1.45	41.13	2.58	73.2	4.02	114.2
300.0	139.0	31.70	63.40	.705	24.0	1.59	54.07	2.82	96.0	4.40	150.2
350.0	150.1	37.08	74.16	.762	30.3	1.71	68.15	3.05	121.2	4.76	189.3
400.0	160.5	42.27	84.54	.814	37.0	1.83	83.25	3.26	148.0	5.09	231.2
450.0	170.2	47.64	95.28	.864	44.2	1.94	99.34	3.46	176.8	5.40	276.0
500.0	179.4	52.84	105.7	.910	51.7	2.05	116.5	3.64	206.8	5.69	323.2
550.0	188.2	58.22	116.4	.955	59.7	2.10	134.2	3.82	238.8	5.96	372.7
600.0	196.6	63.41	126.8	.999	68.0	2.23	152.9	3.99	272.0	6.23	475.0
700.0	212.3	73.98	148.8	1.06	85.7	2.46	192.8	4.36	342.8	6.79	535.5
800.0	226.9	84.55	169.1	1.15	104.7	2.58	235.5	4.60	418.8	7.19	654.0
900.0	240.7	95.14	190.3	1.22	124.9	2.75	281.0	4.88	499.6	7.63	780.5
1000.0	253.8	105.6	211.2	1.29	146.2	2.89	329.0	5.16	584.8	8.04	914.0

TABLE No. 11—Continued.

Flow of Water through Nozzles—Quantity and Horse-power.

Head.	Velocity per second.	150 M. Inch. 3 cu. ft	200 M. Inch. 4 cu. ft.	Diameters of Nozzles.							
				3 Inches.		3.5 Inches.		4 Inches.		4.5 Inches.	
Feet.	Feet.	H. P.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.
1.0	8.025	.308	.424	.372	.040	.50	.056	.666	.072	.84	.090
1.5	9.83	.474	.632	.444	.076	.61	.105	.800	.136	1.00	.171
2.0	11.35	.633	.844	.520	.116	.70	.160	.928	.208	1.17	.260
2.5	12.68	.792	1.06	.580	.164	.79	.224	1.02	.288	1.30	.370
3.0	13.90	.951	1.27	.636	.216	.86	.295	1.14	.384	1.43	.485
3.5	15.01	1.11	1.48	.684	.272	.94	.370	1.22	.480	1.54	.612
4.0	16.05	1.26	1.68	.742	.332	1.02	.452	1.30	.592	1.64	.742
4.5	17.02	1.42	1.90	.776	.396	1.06	.540	1.38	.704	1.74	.815
5.0	17.95	1.58	2.12	.820	.452	1.11	.620	1.46	.816	1.84	1.02
6.0	19.66	1.90	2.54	.896	.612	1.22	.833	1.60	1.09	2.01	1.38
7.0	21.23	2.22	2.96	.968	.772	1.32	1.05	1.73	1.38	2.18	1.74
7.5	21.98	2.38	3.16	1.00	.856	1.36	1.16	1.78	1.52	2.25	1.92
10.0	25.38	3.18	4.24	1.16	1.32	1.57	1.79	2.16	2.34	2.61	2.97
12.5	28.37	3.96	5.28	1.30	1.84	1.76	2.50	2.30	3.46	2.92	4.14
15.0	31.08	4.77	6.36	2.42	2.42	1.93	3.29	2.53	4.32	3.19	5.44
17.5	33.57	5.55	7.40	1.53	3.13	2.08	4.20	2.72	5.44	3.44	7.04
20.0	35.89	6.33	8.44	1.64	3.72	2.23	5.07	2.91	6.64	3.69	8.37
22.5	38.07	7.14	9.52	1.74	4.44	2.36	6.05	3.09	7.92	3.91	9.92
25.0	40.13	7.92	10.56	1.83	5.20	2.54	7.08	3.26	9.24	4.12	11.70
27.5	42.08	8.70	11.60	1.92	6.00	2.61	8.17	3.41	10.68	4.32	13.50
30.0	43.95	9.06	12.08	2.05	6.84	2.79	9.31	3.65	12.16	4.61	15.39
32.5	45.75	10.02	13.36	2.09	7.72	2.84	10.50	3.71	13.72	4.70	17.37
35.0	47.47	11.07	14.76	2.17	8.60	2.95	11.71	3.86	15.32	4.88	19.35
40.0	50.75	12.66	16.88	2.32	10.52	3.15	14.33	4.12	18.72	5.22	23.67
45.0	53.83	14.25	19.00	2.46	12.56	3.34	17.10	4.36	22.40	5.54	28.25
50.0	56.75	15.84	21.12	2.59	14.72	3.52	20.03	4.60	26.24	5.83	32.12
60.0	62.16	19.02	25.36	2.84	19.36	3.86	26.32	5.04	34.40	6.39	43.55
70.0	67.14	22.17	29.56	3.06	24.40	4.17	33.17	5.42	43.36	6.84	54.90
80.0	71.78	25.36	33.86	3.28	29.80	4.46	40.55	5.84	52.96	7.38	67.05
90.0	76.13	28.59	38.12	3.46	35.52	4.73	48.37	6.16	63.20	7.78	79.92
100.0	80.25	31.68	42.24	3.66	41.64	4.98	56.67	6.52	74.08	8.23	93.70
125.0	89.72	39.63	52.84	4.08	58.20	5.57	79.20	7.28	103.5	9.18	130.9
150.0	98.28	47.55	63.40	4.48	76.48	6.10	104.10	8.00	136.0	10.08	172.1
175.0	106.1	55.50	74.00	4.84	96.28	6.60	131.07	8.04	171.2	10.89	216.6
200.0	113.5	63.42	84.56	5.16	117.7	7.05	160.22	9.20	219.6	11.61	264.7
250.0	127.1	79.26	105.7	5.80	164.5	7.88	223.92	10.32	292.8	13.05	370.2
300.0	139.0	95.10	126.8	6.36	216.3	8.63	294.3	11.28	384.0	14.31	486.9
350.0	150.1	111.2	148.3	6.84	272.6	9.33	371.2	12.20	484.8	15.39	613.2
400.0	160.5	126.8	169.1	7.32	323.0	9.97	453.2	13.04	592.0	16.47	749.2
450.0	170.2	142.9	190.6	7.75	397.4	10.58	541.0	13.84	707.2	17.46	894.2
500.0	179.4	158.5	211.4	8.20	466.0	11.15	627.0	14.56	827.2	18.45	1048.0
550.0	188.2	174.7	232.8	8.40	536.8	11.69	731.0	15.28	955.2	18.90	1208.0
600.0	196.6	190.2	253.6	8.92	611.0	12.21	832.7	15.96	1088.0	20.07	1376.0
700.0	212.3	221.9	296.0	9.84	771.2	13.31	1051.	17.44	1371.2	22.14	1735.0
800.0	226.9	253.6	338.2	10.32	942.0	14.10	1282.	18.40	1675.2	23.22	2119.0
900.0	240.7	285.4	380.6	11.00	1124.	14.90	1530.	19.52	1998.4	24.75	2529.0
1000.0	253.8	316.8	442.4	11.56	1316.	15.76	1791.	20.64	2339.2	26.00	2961.0

TABLE No. 11—Continued.

Flow of Water through Nozzles—Quantity and Horse-power.

Head.	Velocity per second.	300 M. Inch. 6 cu. ft.	400 M. Inch. 8 cu. ft.	DIAMETERS OF NOZZLES. 5 inches.		5.5 inches.		6 inches.		7 inches.	
Feet.	Feet.	H. P.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.
1.0	8.025	.616	.88	1.02	.116	1.23	.140	1.49	.100	1.99	.226
1.5	9.83	.948	1.26	1.25	.212	1.51	.257	1.78	.304	2.44	.420
2.0	11.35	1.27	1.69	1.44	.327	1.74	.395	2.08	.464	2.82	.641
2.5	12.08	1.58	2.11	1.61	.457	1.95	.553	2.32	.656	3.15	.896
3.0	13.90	1.90	2.54	1.76	.601	2.13	.227	2.54	.864	3.45	1.18
3.5	15.01	2.22	2.96	1.90	.757	2.31	.916	2.74	1.09	3.78	1.48
4.0	16.05	2.53	3.37	2.03	.925	2.46	1.12	2.97	1.33	4.09	1.81
4.5	17.02	2.84	3.79	2.16	1.10	2.51	1.33	3.10	1.58	4.23	2.16
5.0	17.95	3.18	4.24	2.27	1.26	2.75	1.53	3.28	1.81	4.40	2.48
6.0	19.66	3.81	5.08	2.49	1.70	3.02	2.05	3.58	2.45	4.88	3.33
7.0	21.23	4.44	5.92	2.69	2.14	3.26	2.69	3.87	3.09	5.28	4.20
7·5	21.98	4.74	6.32	2.79	2.38	3.42	2.87	4.00	3.42	5.40	4.66
10.0	25.38	6.36	8.48	3.22	3.66	3.89	4.42	4.64	5.28	6.30	7.16
12.5	28.37	7.92	10.56	3.59	5.11	4.35	6.18	5.20	7.30	7.05	10.02
15.0	31.01	9.54	12.72	3.94	6.72	4.76	8.13	5.68	8.08	7.72	13.17
17.5	33.57	11.10	14.80	4.26	8.46	5.15	10.24	6.12	12.52	8.34	16.80
20.5	35.89	12.66	16.88	4.55	10.34	5.50	12.51	6.56	14.88	8.92	20.28
22.5	38.07	14.28	19.04	4.83	12.34	5.84	14.93	6.96	17.76	9.46	24.20
25.0	40.13	15.84	21.12	5.09	14.45	6.16	17.49	7.32	20.80	10.13	28.33
27.5	42.08	17.40	23.20	5.34	16.67	6.46	20.18	7.68	24.00	10.10	32.08
30.0	43.95	18.12	24.16	5.70	19.00	6.90	22.99	8.20	27.36	11.18	37.25
32.5	45.75	20.04	26.72	5.80	21.42	7.02	25.92	8.36	30.88	11.37	41.99
35.0	47.47	22.14	29.52	6.02	23.94	7.28	28.97	8.68	33.40	11.80	46.84
40.0	50.75	25.32	33.76	6.44	29.25	7.78	35.30	9.28	42.08	12.61	57.33
45.0	53.83	29.50	38.00	6.82	34.90	8.26	42.23	9.84	50.24	13.38	68.40
50.0	56.75	31.68	42.24	7.19	40.87	8.70	49.46	10.36	58.88	14.10	80.11
60.0	62.16	38.04	50.72	7.88	53.72	9.54	65.01	11.36	77.44	15.44	105.3
70.0	67.14	44.34	59.12	8.51	67.72	10.30	81.95	12.24	97.60	16.09	132.7
80.0	71.78	50.74	67.64	9.10	82.76	11.01	100.1	13.12	119.2	17.84	162.2
90.0	76.13	57.18	76.24	9.65	98.72	11.58	119.5	13.84	142.1	18.92	193.5
100.0	80.25	63.06	84.48	10.17	115.6	12.31	139.9	14.64	166.6	19.94	226.7
125.0	89.72	79.26	95.68	11.36	161.6	13.76	195.0	16.32	232.8	22.30	316.8
150.0	98.28	95.10	126.8	12.46	212.5	15.08	257.0	17.92	305.9	24.42	416.4
175.0	106.1	111.0	148.0	13.46	267.5	15.29	313.7	19.36	385.1	26.39	524.3
200.0	113.5	126.8	169.1	14.34	327.0	17.51	395.7	20.64	470.8	28.20	640.9
250.0	127.1	158.5	211.4	16.09	457.0	19.47	553.0	23.20	658.0	31.54	895.7
300.0	139.0	190.2	253.6	17.62	601.0	21.33	726.9	25.44	865.2	34.54	1177.
350.0	150.1	222.5	296.6	19.04	757.2	22.04	916.3	27.36	1090.4	37.32	1485.
400.0	160.5	253.6	338.2	20.35	925.0	24.62	1179.	29.28	1332.	39.89	1813.
450.0	170.2	285.8	381.1	21.59	1104.	26.12	1335.	31.04	1590.	42.31	2154.
500.0	179.4	317.1	422.8	22.75	1293.	27.54	1565.	32.80	1864.	44.00	2508.
550.0	188.2	349.2	465.6	23.86	1491.	28.88	1805.	33.60	2147.	46.78	2923.
600.0	196.6	380.4	507.2	24.93	1699.	30.16	2056.	35.08	2446.	48.86	3331.
700.0	212.3	444.0	592.0	27.18	2142.	32.88	2591.	39.36	3085.	53.26	4203.
800.0	226.9	507.3	676.4	28.77	2616.	34.92	3166.	41.28	3768.	56.40	5129.
900.0	240.7	570.9	761.2	30.52	3122.	36.94	3778.	44.00	4496.	59.80	6120.
1000.0	253.8	633.6	844.8	32.17	3656.	38.93	4424.	46.24	5264.	63.06	7166.

TABLE No. 11—Continued.

Flow of Water through Nozzles—Quantity and Horse-power.

Head.	Velocity per Second.	500 M. Inch. 10 cu. ft.	1000 M. Inch. 20 cu. ft.	Diameters of Nozzles.							
				8 Inches.		9 Inches.		10 Inches.		12 Inches.	
Feet.	Feet.	H. P.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.	Cu. ft.	H. P.
1.0	8.025	1.06	2.12	2.62	.288	3.35	.360	4.07	.46	5.96	.904
1.5	9.83	1.58	3.16	3.20	.544	3.99	.684	4.99	.85	7.12	1.68
2.0	11.35	2.11	4.22	3.71	.832	4.68	1.04	5.76	1.36	8.32	2.56
2.5	12.68	2.64	5.28	4.08	1.15	5.22	1.48	6.44	1.83	9.28	3.58
3.0	13.90	3.17	6.34	4.56	1.54	5.72	1.94	7.05	2.40	10.16	4.72
3.5	15.01	3.70	7.40	4.88	1.92	6.16	2.45	7.62	3.03	10.96	5.92
4.0	16.05	4.21	8.42	5.20	2.37	6.58	2.99	8.14	3.70	11.88	7.24
4.5	17.02	4.74	9.48	5.52	2.81	6.98	3.26	8.64	4.42	12.40	8.64
5.0	17.95	5.28	10.6	5.84	3.26	7.38	4.07	9.10	5.05	13.12	9.92
6.0	19.66	6.34	12.7	6.40	4.36	8.06	5.51	9.97	6.80	14.32	13.32
7.0	21.23	7.39	14.8	6.92	5.52	8.71	6.95	10.77	8.57	15.48	16.80
7.5	24.98	7.92	15.8	7.12	6.08	9.00	7.70	11.14	9.50	16.00	18.64
10.0	25.38	10.6	21.2	8.64	9.36	10.44	11.88	12.87	14.63	18.56	28.64
12.5	28.37	13.2	26.4	9.20	13.84	11.70	16.56	14.39	20.44	20.80	40.08
15.0	31.08	15.9	31.8	10.12	17.28	12.78	21.78	15.76	26.87	22.72	52.68
17.5	33.57	18.5	37.0	10.88	21.76	13.77	28.17	17.03	33.86	24.48	67.20
20.0	35.89	21.1	42.2	11.64	26.56	14.76	33.48	18.20	41.37	26.24	81.12
22.5	38.07	23.8	47.6	12.36	31.68	15.66	39.96	19.31	49.37	27.84	96.80
25.0	40.13	26.4	52.8	13.04	36.96	16.47	46.80	20.35	57.82	29.28	113.3
27.5	42.08	29.0	58.0	13.64	42.72	17.28	54.00	21.34	66.70	30.72	130.7
30.0	43.95	30.2	60.4	14.60	48.64	18.45	61.56	22.81	76.01	32.80	149.0
32.5	45.75	33.4	66.8	14.84	54.88	18.81	69.48	23.20	85.70	33.44	168.0
35.0	47.47	36.9	73.8	15.44	61.28	19.53	77.40	24.08	95.78	34.72	187.4
40.0	50.75	42.2	84.4	16.48	74.88	20.88	94.68	25.74	117.0	37.12	229.3
45.0	53.83	47.5	95.0	17.44	89.60	22.14	113.0	27.30	139.6	39.36	273.6
50.0	56.75	52.8	105.6	18.40	105.0	23.31	128.5	28.78	163.5	41.44	320.4
60.0	62.16	63.4	126.8	20.16	137.6	25.56	174.2	31.53	214.9	45.44	421.2
70.0	67.14	73.9	147.8	21.68	173.4	27.54	219.6	34.06	270.9	48.96	530.8
80.0	71.78	81.6	169.0	23.36	211.8	29.52	268.2	36.41	331.0	52.48	648.8
90.0	76.13	95.3	190.6	24.64	252.8	31.14	319.7	38.61	394.9	55.36	774.0
100.0	80.25	105.6	211.2	26.08	296.3	32.94	374.8	40.70	462.4	58.56	906.8
125.0	89.72	132.1	264.2	29.12	414.0	36.72	523.8	45.51	646.5	65.28	1267.
150.0	98.28	158.5	317.0	32.00	554 0	40.32	688.3	49.85	849.8	71.68	1666.
175.0	106.1	185.0	370.0	34.56	684.8	43.56	866.5	53.85	1070.	77.44	2097.
200.0	113.5	211.4	422.8	36.80	878.4	46.44	1059.	57.56	1308.	82.56	2564.
250.0	127.1	264.2	528.4	41.28	1171.	52.20	1481.	64.36	1828.	92.80	3583.
300.0	139.0	317.0	634.0	45.12	1536.	57.24	1947.	70.50	2403.	101.76	4708.
350.0	150.1	370.8	741.6	48.80	1949.	61.56	2453.	76.15	3029.	109.4	5940.
400 0	160.5	422.7	845.4	52.16	2368.	65.88	2997.	81.41	3700.	117.1	7252.
450.0	170.2	476.4	952.8	55.36	2829.	69.84	3577.	86.35	4415.	124.2	8656.
500.0	179.4	528.4	1057.	58.24	3409.	73.80	4194.	91.02	5172.	131.2	10032.
550.0	188.2	582.2	1164.	61.12	3821.	75.60	4831.	95.46	5966.	134.4	11692.
600.0	196.6	634.1	1268.	63.84	4352.	80.28	5504.	99.71	6798.	142.7	13324.
700.0	212.3	739.8	1480.	69.76	5485.	88.56	6941.	108.7	8567.	157.4	16812.
800.0	226.9	845.5	1691	73.60	6701.	92.88	8478.	115.1	10465.	165.1	20516.
900.0	240.7	951.4	1903.	78.08	7994.	99.00	10116.	122.0	12489.	176.0	24480.
1000.0	253.8	1056.	2112.	82.56	9357.	104.0	11844.	128.7	14624.	185.0	28664.

TO DETERMINE THE FLOW OF WATER THROUGH NOZZLES.

The head of water being three hundred feet, how many miner's inches per second will be discharged from a nozzle four inches diameter?

In the table, find in the first column the given head, 300 feet, opposite which, in column headed "4 inches," will be found 11.28 cubic feet ×50=564 miner's inches, the amount discharged.

Having 1,000 miner's inches of water with three hundred feet head, what will be the size of a nozzle to discharge that quantity of water?

In Table No. 11, find in the first column the given head, 300 feet, and in column opposite, find the number of cubic feet, which, multiplied by fifty, will produce approximately 1,000. In the above case, we have opposite 300 feet head, 21.33 cubic feet $\times 50 = 10.66$ inches, the nearest approximate to 1,000, and at head of that column we find 5″.5 as the diameter of the nozzle required to discharge that quantity of water under the given head.

TABLE NO. 12.

Additional Head Required to Overcome the Resistance of One Circular Bend.

Velocity per Second. Feet.	Ratio of Radius of Pipe to Radius of Bend.									
	1:5 30° Head. Feet	1:5 60° Head. Feet.	1:5 90° Head. Feet.	1:5 120° Head. Feet.	1:5 180° Head. Feet.	2:5 30° Head. Feet.	2:5 60° Head. Feet.	2:5 90° Head. Feet.	2:5 120° Head. Feet.	2:5 180° Head. Feet.
1	.0004	.0007	.0011	.0014	.0022	.0005	.001	.002	.002	.005
2	.0014	.0029	.0043	0058	.0086	.0021	.004	.006	.008	.013
3	.0032	.0064	.0096	.0128	.0191	.0048	.010	.014	.020	.029
4	.0057	.0114	.0171	.0228	.0342	.0085	.017	.025	.034	.051
5	.0089	.0179	.0268	.0358	.0536	.0133	.027	.040	.054	.080
6	.0129	.0257	.0386	.0514	.0772	.0192	.038	.058	.076	.115
7	.0175	.0350	.0525	.0700	.1050	.0261	.052	.078	.104	.157
8	.0229	.0457	.0686	.0914	.1372	.0341	.068	.102	.136	.205
10	.0357	.0714	.1072	.1428	.2144	.0533	.107	.160	.214	.320
15	.0804	.1607	.2411	.3214	.4822	.1200	.240	.360	.480	.720
20	.1429	.2858	.4287	.5716	.8574	.2130	.426	.639	.852	1.28
25	.2232	.4464	.6696	.8928	1.34	.3333	.667	1.00	1.33	2.00
30	.3214	.6428	.9642	1.29	1.93	.4798	.960	1.44	1.92	2.88
40	.5714	1.14	1.71	2.28	3.42	.8530	1.71	2.56	3.42	5.12
50	.8927	1.79	2.68	3.58	5.36	1.33	2.66	3.99	5.32	7.98
75	2.01	4.02	6.03	8.04	11.06	3.00	6.00	9.00	12.00	18.00
100	3.57	7.14	10.71	14.28	21.42	5.33	10.67	15.99	21.34	31.98
150	8.04	16.07	24.11	32.14	48.22	12.00	24.90	36.00	48.00	72.00
200	14.29	28.58	42.87	57.16	85.74	21.32	42.64	63.96	127.92	127.92
300	32.14	64.28	96.42	128.56	192.84	47.98	95.96	143.94	287.88	287.88

TO DETERMINE ADDITIONAL HEAD NECESSARY TO OVERCOME THE RESISTANCE OF ONE CIRCULAR BEND.

The radius of the pipe being to the radius of the bend as 1:5, the number of degrees curvature in the bend being 60° and the velocity of the water through pipe being one hundred feet per second, what additional head is required to overcome the resistance of the bend?

In Table No. 12, in first column headed "velocity per second," look for 100 feet, opposite which in column headed "1:5—60°" will be found 7.14, the additional required head.

The radius of the pipe being to the radius of the bend in the ratio of 2:5, and the number of the degrees in the bend being 120°, and the velocity of the water one hundred feet per second, what additional head will be required to overcome the resistance of the bend?

In Table No. 12, opposite 100 feet velocity, find in column headed "2:5—120°" the additional head required=21.34 feet.

TABLE NO. 13.

Additional Head Required to Overcome the Resistance of One Angular Bend.

Velocity per Second.	Angles of Deflection.					
	15° Head.	30° Head.	40° Head.	60° Head.	90° Head.	120° Head.
Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
1	.0002	.0005	.002	.006	.015	.029
2	.0010	.0019	.009	.023	.061	.116
3	.0022	.0042	.019	.051	.138	.260
4	.004	.008	.035	.090	.245	.462
5	.006	.012	.054	.141	.382	.723
6	.009	.017	.078	.204	.550	1.04
7	.012	.023	.106	.277	.749	1.42
8	.016	.030	.138	.362	.978	1.85
10	.025	.047	.216	.565	1.53	2.89
15	.056	.105	.486	1.27	3.44	6.50
20	.099	.186	.863	2.26	4.85	11.56
25	.155	.291	1.35	4.45	9.55	18.06
30	.224	.419	1.94	5.09	13.75	26.01
40	.398	.745	3.45	9.04	24.45	46.23
50	.621	1.17	5.40	14.13	38.20	73.93
75	1.40	2.62	12.14	31.79	85.95	162.5
100	2.48	4.66	21.58	56.52	152.8	289.0
150	5.59	10.48	48.57	127.2	343.7	650.2
200	9.94	18.63	86.32	226.1	611.1	1156.
300	22.36	41.92	194.20	508.7	1092.	2601.

TO DETERMINE THE ADDITIONAL HEAD OF WATER REQUIRED TO OVERCOME THE RESISTANCE OF ONE ANGULAR BEND IN PIPE.

The velocity being one hundred feet per second, what additional head will be required to overcome the resistance of an angular bend, when the angle of deflection is one hundred and twenty degrees?

In Table No. 13, find in first column headed "velocity per second," 100 feet, opposite which in column headed "120°," head will be found 289 feet, or the additional head required to overcome the resistence of the given angular bend.

RELATION OF CLEAN, SLIGHTLY AND VERY ROUGH PIPES, AS TO THEIR RESPECTIVE CARRYING CAPACITIES.

The tables herein given have been computed for smooth and straight or clean pipes. When, however, the pipe is *slightly rough,* multiply the result determined by the tables by .886. When the pipe is *very rough,* multiply the result determined by the tables by .773.

THE GRIZZLY.

The grizzly is a grating of strong iron or steel bars, so arranged that large bowlders rushing down the sluice may be thrown out and shot over the steep bank into a convenient dump, while the mud, water, fine gravel, and gold, drop through the bars and continue on, flowing through the continuation of the sluice at a lower level. It is, in fact, an automatic sieve on a large scale. The bars are given considerable inclination, so that the bowlders are sent by their own momentum far down the dump. Plank are set at the sides of the grizzly to prevent the rocks from escaping latterly. Much coarse and cumbersome material is got rid of by the grizzly, and it is important, as soon as possible, to introduce one to get rid of the bowlders, which quickly wear out the sluice and pavement. When a favorable site is found, a grizzly is generally put in. No large bowlder can pass the first grizzly, the others being to remove the stones of less size which have passed the first, and which it is not policy to remove until they are well scoured in the sluice, to detach any gold that might adhere to them.

The work done by this simple appliance could hardly be done by any other means, and its application was a happy thought. At the Polar Star, the grizzly bars are of steel, three inches square and fourteen feet long. At some of the mines the grizzlies make bars or dams, which hold back large quantities of debris that would otherwise pass down the stream. This is never by design, but always by accident.

BEDROCK TUNNEL.

In most hydraulic mines, a tunnel is driven from some cañon or ravine to a point below the deposit, through which all the gravel is washed. From its being driven in the solid rock below the auriferous beds and the channel of the ancient rivers, it is technically called the "bedrock tunnel." This tunnel should be low enough to allow the entire contents of the channel to be washed through it. It is generally at least from thirty to forty feet below the surface of the bedrock at the lowest depression. To determine which, a preliminary underground survey is necessary, and to accomplish this, an extensive series of shafts, tunnels, and drifts have sometimes to be sunk and driven. The tunnel varies in magnitude. In the earlier experiences of the hydraulic miners, a tunnel from five to six feet high was considered large, but the increased scale of mining in more recent times has resulted in the construction of bedrock tunnels of greatly increased dimensions. They are now more frequently eight feet high and seven feet wide. Such a tunnel discharging into a six-foot sluics set on a four per cent. grade will admit of the use of from 2,000 to 2,500 inches of water.

The grade of the tunnel is dependent on the difference in altitude and distance between the bedrock and the final dump. When there is sufficient fall at the disposal of the engineers, a four-foot grade is considered under most circumstances to be the most desirable. The percentage grade will be fully described under the head of the main sluice. The above grade carries down any possible amount of debris, and the current is so rapid that the gravel is, to a considerable extent, disintegrated before being delivered to the sluice, with its complication of riffles, undercurrents, and other gold-saving apparatus.

It is usually the case that the bedrock tunnel is only projected after the mines have long been worked superficially through some convenient cañon, or bed of mountain stream. By long-continued work, open cuts of great extent have sometimes been made in the course of surface washings, by which a certain experience has been made, and a general idea of the nature and condition of the bedrock channel, etc., gained. It would be a bold undertaking indeed to lay out works of the magnitude of some of the hydraulic mines in California, without a knowledge of the channel from which it is expected to draw the profits on the capital invested. In a few exceptional instances, the whole workable channel has been emptied without the necessity of a bedrock tunnel; but such cases are rare.

To determine the locality best suited for a bedrock tunnel, the obtainable grade, the lowest point in the basin, and the best place to locate the main sluice and the final dump, much capital and engineering skill are often required; and in some cases disastrous failures have resulted from mistakes in surveys and by miscalculations as to the quantity and quality of the precious metal in the gold-bearing channel.

When the projected tunnel is of unusual length, several shafts are sunk on the line of the survey and down to the grade, from each of which the tunnel is driven in opposite directions, the shafts serving for ventillation and for the rejection of waste matter blasted and dug out in the course of the work. From the face, a tramway and cars are used for the latter purpose. When the tunnel is driven continuously from the outlet to a point under the lowest depression of the gravel basin, the operation of uprising to the upper face of the bedrock is one of great danger, and one that requires all the good sense and judgment of the miner; for there are, in many cases, quicksands and accumulations of water which are likely to break through suddenly in such great quantities as not only to endanger the lives of the workmen, but to destroy the tunnel itself. Should such an accident occur there is no escape for the miners, owing to the length of the tunnel. It is always best to sink a shaft to the bedrock, if this has not already been done in the preliminary prospecting to the point where the chimney is to be upraised, and in case of much water to keep the shaft well pumped out. The chimney is vertical or otherwise, according to the views of the Superintendent, or the nature of the bedrock. It is considered safer to approach the surface at an angle than vertically. It is always a great risk to make an uprise in unknown ground, and without a diamond drill it is a great responsibility to require men to take the personal risk of making the connection. The nature of the ground at the bed rock can be learned by sinking an artesian well to the bed rock. The borings will indicate the nature of the country, and a plummet the quantity of water. If found satisfactory a square shaft, strongly timbered, may be sunk following the circular well. For reasons that will be given below, the timbers should be not only strong but set in sections, or cribs, independent of each other. When all the connections are made and everything is ready, temporary sluice boxes may be laid in the tunnel and the first washing commenced. This is done by bringing the water to the top of the shaft from a low head, in iron pipes, as before described, and setting one or two giants at convenient points. The upper set of timbers are then taken out and the ground loosened with pick and shovel. A stream of water from the giant is turned on, and the stream so managed as to slowly disintegrate the ground and wash everything down the shaft without choking it or the tunnel. This process soon makes a depression to the level of the reduced mouth of the shaft. When sufficiently large the giant is removed to the new level, and the washing continued until the surface is removed and a space as large as desirable cleared off the surface, when a second set of timbers are removed and the same washing repeated. At each successive step the head becomes greater, and the force of the water consequently greater. While this surface washing is going on, the sluices, undercurrents, and other gold-saving apparatus are being constructed. In the meantime a certain quantity of gold is being collected and the mine opened. There is a flume in the North Bloomfield tunnel 1,900 feet long.

It is sometimes considered an advantage to cut the foot wall of the incline uprise into terraces of twenty, thirty, or forty feet, as the case may be. This is thought desirable by some for disintegrating the indurated gravel, and discharging it to the less-inclined main tunnel. Another advantage is claimed for the inclined and terraced uprise: the breaking of the force of the down rush of water and debris, which, in one sheer fall of one hundred feet or more, is liable, if at all soft, to shatter and undermine the bottom of a vertical shaft. To guard against this result, it is sometimes necessary to protect the bottom of a vertical shaft by a pavement of heavy bowlders.

It is customary to use the same pavement in the tunnel that is employed in the sluices yet to be described. The tunnels and shaft increase in size, from the wearing of the water loaded with bowlders and gravel. When 7,000,000 cubic yards of gravel had been washed through the North Bloomfield tunnel, it was found that the tunnel, by friction, had been deepened sixteen inches, and the sides were worn smooth. I noticed the same effect of continual grinding of the bedrock at Gold Run, Placer County, where the uprise and surrounding bedrock had been worn quite smooth. From these facts, some idea may be gained as to the force of the streams used and the disintegrating power of the moving debris. Bedrock tunnels are from a few hundred feet to more than a mile in length, and require from five to seven years to construct. The tunnel of the Polar Star, in Placer County, is six hundred and forty feet long, nine feet wide, and nine feet high. The mouth of the tunnel is five hundred feet above the bed of Bear River, into which it tails. The inner end of the tunnel is thirty-four feet below the upper surface of the bedrock at the lowest point in the channel, and two hundred and nine feet below the original surface of the ground. An inclined uprise was made at an angle of fifty degrees; the uprise was one hundred and fifty feet long, and eight by eight feet square. The tunnel is paved with railroad iron, as wooden blocks would not last for thirty-six hours, on account of the bowlders. This mine has been four years washing out a depression one hundred and forty feet deep, six hundred feet long, and four hundred feet wide, using two thousand inches of water; all of which passed down through the incline and tunnel.

The mouth of the Southern Cross tunnel is 1,200 feet from the Polar Star. It, too, is 500 feet above the bed of Bear River, into which it also tails. The tunnel is 1,050 feet in length, forty feet below surface of bedrock, and 260 feet below original surface of the ground.

The condition of the tunnel is made known by means of signals constructed to meet the requirements of each mine. At the Polar Star, a wire passes through the tunnel, connected with a gong near the pipeman. When for any reason the tunnel becomes choked, or is threatened with such an accident, the watchman at the mouth rings the bell, and the pipeman either turns the water for a time on the clean bedrock, or, in extreme cases, signals to the watchman at the pressure box to shut off the water. In the tunnel of the North Bloomfield, there is a large valve made by suspending a diaphragm of planks from the roof, free to swing with the current. From this valve a wire extends to a movable signal placed on an elevated point within full sight from all parts of the workings. According to the quantity of water flowing in the tunnel, the signal is either elevated or depressed.

The Blue Tent tunnel is 400 feet long, eight feet wide, and nine feet high. The sluice on the inside is built exactly as in the bedrock outside, and paved in the same manner with wooden blocks or cobbles. Being narrower than the tunnel, the space on the sides soon fill with debris and form shelves, upon which the blocks are placed in cleaning up, which is the same as outside, except that artificial light is required. No signals are used in the tunnel, but a man is stationed to watch, who, on any indication of clogging, informs the pipe-man who turns the water on the bedrock, and waits until the tunnel is clear.

The main bedrock tunnel at the North Bloomfield mines in Nevada County is 7,000 feet long. It tails into Humbug Creek and South Yuba River. The tunnel of the American mine, Nevada County, is one mile in length. It required seven years of labor to construct this work. It tails into Middle Yuba. At the Birchville mines, Nevada County, at the time of my visit, a new bedrock tunnel had just been finished, and the uprise was being made. I was shown the point where the opening of the workings would be commenced. The mines had lain idle for five years. The Buckeye mine, Nevada County, and the Milton, very near, both tail into Sweetland Creek.

Bedrock tunnels cost from ten to sixty dollars per running foot, according to the nature of the rock, locality, etc. At Smartsville, the cost is forty dollars maximum, and thirty dollars minimum; North San Juan, forty dollars maximum, and twenty dollars minimum; You Bet and Little York, ten dollars, average. The two tunnels of the Polar Star and Southern Cross cost $95,000; the tunnel of the Nevada mine, Chalk Bluffs, cost $75,000, and at the Bonanza mine, Gold Run, $100,000.

The following extracts relating, to the bedrock tunnel and shaft, are from Mr. Bowie's paper.

TUNNELS AND THEIR LOCATION.

The object of tunnels in gravel mining is to afford suitable means for the hydraulic washing of the auriferous deposits, and from their general relative positions are fitted with sluices to catch the gold from the washings. The size of the tunnel is dependent on the requirements, viz., with a six-foot flume it should not be less than eight by eight; with a four-foot flume, five by seven feet.

Generally the difficulty in locating tunnels is to find suitable places which do not involve heavy expenditures. Some idea of the extent of these preliminary operations may be obtained from the following memoranda concerning several tunnels on the ridge (Nevada County) driven within a few years past:

Name of Mine or Tunnel.	Locality.	Length.	Average Grade.		Reported Cost.
			Inches per sluice-box.	Feet per 100.	
		Feet.	Inch. Feet.		
Boston	Woolsey's Flat	1,600	10½ to 12	7¼	$40,000
North Bloomfield	Humbug Cañon	8,000	6½ to 12	4½	*500,000
Farrell	Columbia Hill	2,200	6 to 14	3½	Not Complete.
English Mine	Badger Hill	1,400	12 to 14	7	----
American	Below San Juan	3,900	10½ to 14	6¼	†140,000
Manzanita	Sweetland	1,740	7 to 14	4⅙	62,000
Sweetland Creek	Sweetland	2,200	8 to 14	4⅔	†90,000
Bedrock	Below Sweetland	2,600	9 to 14	5¼	----
French Corral	French Corral	3,500	8 to 14	4⅔	165,000

* With eight auxiliary shafts, increasing the cost, but diminishing the time required.
† Not from official reports.

To these may be added the principal tunnels driven in the mining district of Smartsville:

Name of Tunnel.	Locality.	Length.	Average Grade.	
			Inches per Sluices.	Feet per 100.
		Feet.	Inches. Feet.	
Babb	Timbuctoo	1,200	5½ to 12	3.8
Pactolus	Timbuctoo	1,700	6 to 12	4.16
Rose's Bar	Timbuctoo	1,600	6 to 12	4.16
Blue Gravel	Succor Flat	1,100	6½ to 12	4.5
Pittsburg	Succor Flat	900	6 to 12	4.16
Blue Point	Succor Flat	2,250	6 to 12	4.16
Enterprise	Succor Flat	1,200	6 to 12	4.16
Deer Creek	Mooney Flat	2,200	5 to 12	3.4

In the locating of drainage tunnels, or in the opening of hydraulic claims which do not require tunnels, that place is to be selected from which the sluices, running on the straightest line, with a given grade, can bottom the major part of the "pay deposit" at the smallest possible expense.

In the establishment of this line, due regard should be had for the dump, and allowance made for contingencies arising from changes, such as depressions and holes in the bedrock. It is advisable, besides allowing for grade and dump, to run the tunnel or cut from a point sufficiently deep to strike from fifty to seventy-five feet below the top of the bedrock at the point where connection is to be made with the surface.

This additional depth is a matter of judgment, and, in determining it, one should be governed by the character of the bedrock, extent of ground to be worked, and the position of the shaft. It is always an easy matter to ease up the grade, but if the main line of drainage is once fixed, and proves to be too high, it is a source of endless expense, and is frequently fatal to the enterprise.

At the Pioneer Mine, Grass Flat, Plumas County, the original owners in opening their claim ran a tunnel four thousand feet long. When midway in the channel the tunnel was found to be twenty-two feet above the bedrock. The sum of $60,000, expended in this work, was a total loss.

When a tunnel is used to open a claim it should be driven well into the channel before any connection is made with the surface. The shaft which connects with the heading should be vertical. Its size is to be determined by the requirements of the work, four by four or five by nine feet in the clear, according to circumstances. Whilst raising from the tunnel due precaution should be taken against accidents arising from the rush of water, sand and gravel, which is liable to occur when the bottom of a deposit is tapped.

When a shaft five by nine in size is sunk, it should be divided into two compartments, one of which will serve as a manway, and in the event of obstructions arising in the other compartment, this one can be used in removing them. There is some difference of opinion as to the use of vertical shafts; also as to the expediency of making direct connection between the shaft and tunnel. Respecting the former, it may be observed that a vertical shaft, when properly timbered, is the most desirable and most economical to use for opening hydraulic claims. With drops two hundred feet, no difficulty in working has been experienced. As regards the direct connection of the shaft with the tunnel, where the work is well constructed, no trouble or setback will be encountered in adopting this method of mining. Where a tunnel has to be extended beyond the shaft, it is sometimes convenient to sink the shaft off to one side of the tunnel, connecting it by means of a short drift. In general, where an extension of the tunnel has become necessary, the shaft has been reduced to a drop-off of fifty to sixty feet, or bedrock cuts have lowered it to a level, and consequently the tunnel as extended will diverge from the course of the main tunnel. This is especially the case when the main tunnel enters, as is most usual, the channel at an angle to its general course.

To avoid any accident or trouble, such as might be occasioned by caving of the shaft, it should be strongly timbered and closely lagged, and lined on the inside with two-inch lumber to within, say, eight feet of the surface. This top being the first washed off is used for fall. When in soft rock, the shaft should be timbered close with timbers of the requisite size. These timbers are then lined on all four sides with blocks of wood from four to six inches in thickness set on the end of the grain.

The bottom of the shaft can be protected against wear by using pieces of heavy logs or sticks of twelve inches square timber stood on end securely bound together, or it can be paved with heavy stones, but in many cases the bare bedrock only is used. The last fifty to seventy-five feet of the tunnel which connects with the shaft should be heightened from eight to twelve feet, and at their junction the ground should be securely timbered and protected.

With long tunnels, it is advisable to sink a second shaft at a convenient distance from the heading. As a precautionary measure, a man is sometimes placed in the tunnel to watch the runnings, and in such cases a second shaft is indispensable. Should an accident occur at the main shaft, by its caving or closing up, the second shaft would also afford the necessary facilities for reopening the work.

THE SLUICES.

The modern hydraulic sluice is, in every sense, the sluice box of the pioneer placer miner, greatly enlarged and improved. It may be described as being a well built continuous trough, from three to six feet wide, and from thirty to forty inches deep. It is built of heavy plank, spiked inside a framework of scantling set on sills of timbers four by six inches square. The sills are set four feet apart; they are longer than the width of the sluice; upright posts are morticed into them, the tops of which are braced to the extended portion of the sills. Along one side of the finished sluice, from the top of one post to another, heavy planks are sometimes laid to serve as a gangway up and down the sluice. This is the more necessary when the structure extends across irregular ground, it being essential that the whole length can be carefully watched. All the gold passes through this channel, and is finally distributed throughout its entire length, and must be recovered in the clean-up from the sluice and its branches.

The length of the sluice is governed by circumstances, there being certain considerations, which are carefully studied and well understood by the hydraulic miners. Some of the sluices in California are several thousand feet in length; this extension being necessary to carry the tailings to a distant and carefully selected dump; it being essential to remove the detritus as far as possible, to avoid any stoppage between the mine and the final dump. A long sluice also insures more perfect disintegration of the gravels, and consequently a greater yield of gold, as more opportunities are offered for it to settle into the irregularities in the pavement of the sluice.

The capacity of the sluice is regulated by the grade and the quantity of water used. It has been calculated that a six foot sluice three feet deep, set on a five per cent grade, will carry 3,500 inches of water. One four feet wide, two and a half deep, on a four per cent grade, will carry 2,000 inches. If the dimensions are reduced to three feet wide, with a one and a half per cent grade, the capacity would be 800 to 900 inches.

When possible, the sluice should be carried in a direct line, as curves and angles not only retard the flow of the water, but give it more work to do in carrying forward the debris. In case a curve cannot be avoided, it should be given as long a radius as possible, and the outer side of the sluice should be slightly raised to overcome the tendency of the water to flow to that side. When it is desirable to make the clean-up without discontinuing the washing, a double sluice is sometimes laid, one being used while the other is cleaned up; but as the sluice is a very costly structure, it is generally found to be more economical to discontinue the washing, and to dispense with the secondary portion. In large sluices there is sometimes a small sipage flume of twelve inches inside measure, and near the upper edge of the main sluice; this is only used while cleaning up. A dam of earth is put in near the head of the sluice which causes the sipage water, and perhaps a few inches more from the ditch, to flow into the small flume from which it is drawn as required in cleaning up.

Much care is taken and large expense incurred to render the sluices strong and stable. They are often sunk deep in the bedrock, or, when crossing ravines or cañons, laid on strong trellisses of heavy timbers.

When the grade of the sluice has been decided upon, the same incline should be maintained throughout its entire length, with certain exceptions to be mentioned. In establishing the grade regard should be had to the facilities for placing the undercurrents, necessary drops, grizzlies, etc., each of which is an important factor in the future success of the enterprise.

In early times a length of sluice box was understood to be twelve feet, this being a convenient and procurable length, furnished by the saw mills. From this fact grew the custom of measuring the continuous sluice by the length of a single joint, and it became customary to call a fall of six inches in a twelve-foot length a "six-inch grade." The same custom prevails quite extensively at the present time; but a new method of measuring is coming into use, known as the percentage measurement, six feet fall in one hundred feet of sluice being called a six per cent grade. The grade of the sluice is found to vary from two and a half to eight per cent. The incline in the Milton main sluice is five degrees, which is equal to eight per cent, and to twelve inches to twelve feet a four per cent grade may be taken as the average. Various circumstances influence the grade required. In case the gravel is hard and much mixed with clay, a grade of eight per cent is sometimes given; on the other hand, when the material is loose and easily disintegrated, and specially where there is but little fall to spare, the inclination may be reduced as low as two and a half per cent. This may, however, be taken as the minimum, a steeper grade in all cases being desirable if it can be had.

Immediately below every hydraulic mine there must be fall enough not only to carry the tailings through the sluice, but also to run them to such a distance that they will not so accumulate as to obstruct the outlet of the mine. Whatever spare fall there may be below, between the mine and the final dump, over and above the general incline of the line of the sluice, should be, and generally is utilized, to crush and disintegrate any cemented gravel that may require it. It is not uncommon to make a sudden drop in the line of the sluice of 100 feet or more. The drop is so arranged that the entire contents of the sluice fall on an exposed portion of the bedrock, flowing again into the lower sluice, which carries it forward on the same incline as the upper portion.

It will be understood that no cement gravel can withstand such a shock, and that a portion of gold must be set free that might otherwise escape with the debris. Some operators deem it better to divide the fall into a number of lesser drops, aiming, however, to effect the same object as in the other case. All the water used in the mine passes through the sluice in a muddy torrent.

The sluice, so far as described, would not withstand the rush of water, charged with gravel, small bowlders, and angular masses of rock resulting from the blasting of larger bowlders in the mine; nor would the gold remain in it. To fit it for saving gold, and to protect the walls and floor from the effect of the excessive friction, it must be paved, and the sides lined with wooden blocks or stones. It is important, too, that the lining can be easily removed when too much worn and in cleaning up. This is effected in a variety of ways, the usual materials being wooden blocks, broken granite, or other hard stone blocks, rounded cobble stones, and railroad iron. In a few cases, where the wear is not great, saplings and scantling laid lengthwise, have been substituted. In some instances, where large bowlders are to be run, the scantlings have been protected by thick plates of iron nailed on top. The experience made in such cases probably led to the introduction of railroad iron. The rails generally used are those too much worn to be safe or economical for railroad purposes, or other discarded rails. Along the line of the Central Pacific, certain mining companies have found the latter method of paving their sluices so satisfactory that they buy all the spare rails that can be purchased, at the rate of sixty-five dollars per ton. While this seems be a high price, yet experience has taught that in the end such pavement is cheapest. In the roughest mines, it will last during continuous working for six months or more, during which time the labor of repairing is much abridged, and consequent stoppages avoided. Iron rails are also found to make better riffles than any other materials, being admirably formed to allow the gold to settle between them. It may be found advantageous in the future to manufacture rails purposely for the use of the mines, and, as at the present time of writing there seems to be a prospect of the development of extensive iron manufacturing in the State, those engaged in iron works may reasonably look in this direction for a partial market for their productions.

The rails in the Polar Star tunnel are laid lengthwise on cross-scantling four by six and six feet long. The rails have quite a space left between them, into which the gold falls and is saved.. No quicksilver is used in the tunnel, except in cleaning up.

The blocks used for sluice pavements are specially prepared, being manufactured at the saw mills and sold in quantities to suit. They are generally eight to ten inches thick and from twelve to eighteen inches square. The mode of laying wooden block pavement is as follows: Commencing at one end a row of blocks is laid across the floor of the sluice, and made to cover the whole space. Across these blocks a strip of one and one half inch plank six inches wide is set on edge and nailed. The nails are made for this purpose expressly, having two points, and being thicker in the middle they are not wholly driven in, but the ends left projecting. A second course of blocks is laid which are driven against the projecting nails snug against the plank strip. A second plank is spiked with projecting nails and the process continued until the whole floor or bed of the sluice is covered with blocks. The narrow depressions caused by the introduction of plank, serve as riffles to collect and retain the gold and quicksilver. The blocks are cut across the grain of the wood and are so set that the grain is vertical, as the blocks stood in the tree. At Blue Tent, Nevada County, Mr. Hughes used finishing nails having small heads to fasten the blocks. When the floor is laid, the side blocks, which are four to six inches thick, are fastened with small nails, and the lining is then complete. At the Malakoff Mine, at North Bloomfield, Nevada County, the blocks are thirteen inches thick. They last four runs of two weeks each. Mr. Stubbs informed me that his experience had been that it did not pay to burn them when worn out, a plan adopted by many miners to recover the gold from the ashes. It is claimed by other superintendents that the gold obtained by burning will pay for new blocks.

When sluices are paved with stone, which some prefer, the same general plan is adopted. When cobbles are used, they are generally set in compartments, separated from each other by strong timbers.

In selecting the cobbles, flat stones are preferred; in setting, they are placed edgewise, inclining down stream. While cobble stones are cheaper than wooden blocks at the outset, their use is attended with disadvantages otherwise; more labor is expended in removing and replacing them in the clean-up; the stone paved sluice also requires more water, and a steeper grade to rush through the same quantity of material. Wooden blocks are also better adapted for saving gold, for which reason it is sometimes thought to be an advantage to interpose a portion of wooden pavement at some point near the outlet of the bedrock tunnel. In some mines, roughly squared blocks of granite are employed, in which case occasional cross scantling are spiked to the floor to prevent the blocks from slipping in the bed. The sluice of the Milton Company is more than a half mile long, and is paved with granite blocks. When this stone pavement is laid, side blocks of wood are nailed on above them, to protect the sides and to hold the pavement in place. The sluice of the Amador Gravel Company, near Jackson, Amador County, is paved with alternate blocks of wood and bowlders. The paving blocks are six by seventeen inches, and eight inches deep. No nails are used, and there are no side blocks. When the blocks are all in place, lengths of three by four scantling are nailed along the sides of the sluice. The sluice has a six-inch grade. The tailings are dumped on the ground, near the mine, but the water used flows into the middle fork of the Jackson. The word flume is erroneously used for sluice. A flume is similarly constructed, but is only used as a conduit for water.

The final dump is located, when possible, on the bank of a mountain river, or in a steep, lateral cañon. It is essential that it should be as high as possible above the stream, so that there cannot be an accumulation so large as to endanger the working of the mine. When a rapid, powerful river is near at hand, tho question of elevation is not of so much importance, for, during the winter floods, the accumulations of the summer are swept away. Most of the companies on the Trinity and Klamath rivers depend on those streams to keep the outlet of the mines free from tailings. In neglecting these considerations, many a promising mine has been abandoned that, otherwise, might have been worked profitably, and produced largely of the precious metal.

The following extracts relating to the sluices and dump are from Mr. Bowie's paper:

SETTING SLUICES AND THEIR CONSTRUCTION.

In setting sluices, a straight line should be adopted, and where curves occur, the outer side of the box is slightly raised, in order to cause a more general distribution of the materials over the riffles.

Sluices are made of one and one half inch plank, tongued and grooved, resting on sills four by six inches. To securely tighten the bottom of the sluices, the planks should be grooved and then joined together by driving in a soft pine tongue. The posts are four by three inch scantling. The size of the sluice is regulated by the grade, character of the gravel, and quantity of water to be used. A sluice six feet wide and thirty-six inches deep, on a four or five per cent. grade, will suffice for running 3,000 to 3,500 miner's inches of water. One four feet wide, thirty-six inches deep, on a four-inch grade to sixteen-foot boxes, will suffice for 1,200 to 1,500 inches of water, and on a four per cent grade it is large enough for 2,000 inches. A sluice three feet wide and thirty inches deep, with a one and one half per cent grade is ample for 1,000 to 1,200 inches.

The requisite length of the sluice is determined by the character of the gravel to be washed, volume of water used, grade and size of sluices, the principle being to construct the line sufficiently long to insure the most complete disintegration of the gravel, thus affording ample surface for the grinding of the cement, and offering under such conditions the best facilities for the gold to settle in the riffles.

The facility with which gravel can be moved by water depends mainly on the inclination which can be given to the sluices. The question of grade is, therefore, one of vital importance, and to carefully investigate and determine this question great care and skill are often required.

When the topography of the country admits of unlimited fall, the grade or incline upon which the sluices are set should be regulated by the character of the gravel to be moved. Where the wash is coarse and cemented, requiring blasting, or where there is much pipe-clay, a heavy grade is requisite. Strongly cemented gravel requires falls or drops to break it up. To prevent the loss of gold, grizzlies and undercurrents are used to relieve the sluices of the finer material containing gold already detached and being carried forward by a strong stream and heavy grade.

Experience so far has led to the adoption, in most localities, of what is called a six-inch grade, meaning six inches to the box twelve feet long, or say four per cent grade. In some places, where large quantities of pipe-clay are washed off, nine and twelve inch grade to the box is used (six to eight per cent); in others, on account of natural obstacles encountered, a one and one half per cent grade, or two and one half to three inches per box of sixteen feet is used. Light gravel can be moved on an easier grade and with less water than heavy gravel, nevertheless, when a four per cent grade can be obtained it is desirable, as it lessens the labor of handling rocks. Moreover, as light gravel is generally poor in gold, this deficiency can only be made up by washing large quantities of it. On the other hand, coarse gravel demands from four to seven per cent grades, and a proportionate increase of water.

In washing heavy gravel, the water in the sluices should be deep enough (ten to twelve inches) to cover the largest bowlders ordinarily sent down, while light gravel requires the water to run in sufficient force to carry the rocks washed through the sluice, and yet be in only sufficient volume to prevent the packing of black and heavy sand. If too much water is used by superincumbent pressure the sand drops and packs the riffles. The best results are obtained with shallow streams on light grades.

Square blocks of suitable length and breadth (eight to twelve inches deep), called riffles, arranged with spaces of one to one and a half inches between each cross row, are used to line the bottom of the sluices. They are held in position by small boards, one and a half by six inches, fastened crosswise on the bottom between the rows, by means of headless nails, and made secure by a cleat one and a half by three inches, nailed longitudinally on top of the blocks on both sides of the sluice. This method of setting riffles is falling somewhat into disuse. Block riffles are now frequently set and held firm in position by means of soft pine wedges driven between the blocks and the sides of the sluice. When wedges are used, it is necessary that the sides of the blocks should be square where they adjoin one another. A side lining is required in all sluices. In cement claims, blocks four inches thick, eighteen by twenty-four inches in size, are used for side lining.

In many localities round stones, instead of blocks, are used for riffles, and where heavy cement is washed these are considered preferable on account of their cheapness. At Smartsville they have been found to serve fully as well as the blocks, and are claimed to be cheaper. It must, however, be stated that they are more costly to handle, as longer time is required to clean up and repave the sluices when they are used. In some sections of the State longitudinal riffles are preferred, *i. e.*, riffles made of scantling placed lengthwise in the sluice. It is frequently the case that the several kinds of riffles are used in long sluices. Where the banks contain many large bowlders, as at the Paragon Mine, a different style of riffle has been introduced. These riffles are made of six-inch scantling, one and one half inches wide, eight feet long, separated by blocks one and one half inches wide, and an iron bar one and one half inches wide, one inch deep, and eight feet long, is fastened on top of each scantling. The grade of these sluices is eighteen inches per twelve foot box, and the width of sluice is forty-four inches.

A system of riffles consisting of a row of blocks alternating with an equal section of rocks has been found to work successfully. This arrangement of the sluices materially reduces the wear and tear of the blocks, and has given excellent results. The block and rock riffles are not desirable for those sluices which have frequently to be cleaned up. So far, experience shows square block riffles to be the best for saving gold. The objection to their use is the cost of wear and tear. The most economical substitute is rocks, but sluices set with them require steeper grades and more water than those arranged with blocks. As a matter of convenience and economy, block riffles should be used in the head sluices of those claims where the gravel is rich, or where a large amount of gold is monthly produced and cleaned up.

THE UNDERCURRENT.

The undercurrent is an auxilary sluice much wider than the main one, and placed on either side at irregular intervals, where it can be set to advantage. In the undercurrent the water does not run so rapidly, nor is it so deep, which conditions allow the fine gold to settle, by reason of its great specific gravity. At each point where an undercurrent is set, an iron grating, which is a miniature grizzly, is inserted in the floor of the sluice, which generally terminates at this point, but is resumed at a lower level. A part of the water, after passing through the grating, flows laterally into the head of the undercurrent, over the surface of which it spreads evenly, being directed by small board guides, set on edge and at the proper angle with the current; the remainder of the water and the coarse material pass over the grating, fall into the sluice at a lower level and continue on. The undercurrent is paved like the sluice, but generally the blocks are smaller. The interstices in the pavement are well charged with quicksilver, gold settles in part as the water before mentioned flows over the face of the undercurrent. At the lower end there is also a small side flume, which returns the water to the sluice.

Other undercurrents are set in succession, over which the finer material flows and is returned to the main channel. This is repeated as long as considered necessary. At the American mine, near North San Juan, there are twenty undercurrents, and the last one is found to save some gold; other mines have as many if not more. Undercurrents are made from ten to forty feet wide and from twenty to sixty feet long, according to the magnitude of the works. The usual inclination is ten to twelve inches in twelve feet, which is about equal to five degrees. If the whole sluice could be constructed on the plan of the undercurrent, both wide and shallow, more gold could be saved; but this is impossible, owing to the necessity of a forcible rush of water to carry off the refuse matter in the present mode of working. The bars of the grating are laid across the bottom of the sluice, at right angles with its direction in which the grating differs from the grizzly, the bars of which lie in the direction of the stream.

At Gold Run the undercurrent bars are four inches wide, three quarters of one inch thick and six feet long, set in a strong rack of of cast iron. The bars are set at an angle so that any gravel or other coarse matter passing through the upper slit cannot fail to pass through. The main sluice, extending along the undercurrent, is given a steeper grade to compensate for the volume of water diverted to the undercurrent; the same effect is sometimes obtained by narrowing the sluice to the extent of six inches or more.

The number of undercurrents is governed by the fall and the distance from the mouth of the bedrock tunnel to the final dump. Miners generally put in as many as possible. In some cases, where the grade requires to be economized, the undercurrents are set opposite to each other on either side of the main sluice, where the contour of the ground renders such an arrangement possible. In cases where these structures can only be introduced at a few points, they are likewise set on both sides of the main sluice, and are sometimes double banked.

In addition to saving fine gold, the undercurrent serves to arrest and retain a portion of the rusty gold, which does not amalgamate, and gold the specific gravity of which is diminished by being attached to quartz or other gangue minerals; such composite particles being caught by the extensive system of riffles formed by the joints in the pavement. On the line of the main sluice, below the point where the muddy water is returned, it is customary to place a stone-paved cistern, similar to the sand boxes already described, to catch any stray particles that may have escaped the undercurrent. Copper plates are not used in the undercurrents. At some mines the undercurrents are paved with wooden blocks, at others, stone only is used; while still in others, iron riffles are substituted for the pavements.

In the construction of undercurrents, much depends on the judgment and mechanical ability of the superintendent and his assistants. The general construction will be the same, but material improvements will naturally suggest themselves to the management at any new locality where the conditions are peculiar.

There are five undercurrents in the Blue Tent mines, Nevada County, which save from twenty to thirty per cent of the gold. It has been noticed that the gold from the undercurrents is finer in quality than that taken from the main sluice. The undercurrents of the Amador Gravel Company are all paved with stone; those at the North Bloomfield are thirty-six by forty-eight feet area. Six and eight tenths of the total yield of gold is saved in them.

The following is quoted from Mr. Bowie's paper:

In the heavy cement at French Corral and Manzanita a high percentage of the gross yield of the mines is found in the undercurrents. Hydraulic mining in the so-called cement claims is carried on under great difficulties. An exhibit of the workings of the sluices of a representative cement claim (French Corral) is here given, and the contrast thus afforded with the workings of sluices, in the generality of cases, is most striking and especially interesting. The washings from the French Corral mine, after passing through the new tunnel, are distributed successively over nine undercurrents before they are finally discharged. The sizes and arrangement of the undercurrents are given in the accompanying table:

FRENCH CORRAL MINE—UNDERCURRENTS, ETC.

Undercurrents.						Secondaries.			Chutes.	
From mouth of Tunnel down.	Number of Boxes.	Length over all.	Width of two Compartments.	*Grade—Whole amount	Bottom Lined With.	Length	Width	Grade	Length	Width
		Ft.	Ft.	Ft. In.		Ft.	Ft.	Ft. In.	Ft.	Ft.
No. 1	3	42	20	3.9	4-inch blocks, 6-in. by 12-in. by 4-in.	----	----	------	†	5
No. 2	3	42	20	3.9	West side, blocks; east side, 1 box blocks; west side, blocks; 2 box riffles	21	12	1.10½	42	6
No. 3	3	42	20	3.9	Upper box, each side, blocks; 2d box, do; 3d box, each side, riffles.‡	----	----	------	28	6
No. 4	3	42	20	3.9	Same as No. 3	----	----	------	28	6
No. 5	3	42	20	3.9	Same as No. 3	----	----	------	42	6
No. 6	3	42	20	3.9	Same as No. 3	----	----	------	28	6
No. 7	3	42	20	3.9	Same as No. 3	21	12	1.10½	42	6
No. 8	3	42	20	3.9	Same as No. 3	----	----	------	28	6
No. 9	3	42	20	3.9	Same as No. 3	28	12	2.6	28	6

* Grade, 15 inches to 14 feet.
† Main Sluice.
‡ Riffles—made in frames 7 feet long, 20 inches wide, from slats 1¼ by 4 inches, ¾ of an inch apart. The bottoms of the undercurrents were lined with slat riffles until clean-up of July 21st.

BOWLDER BLASTING.

The force of water from the giant washes away loose matter, such as mud, sand, gravel, and small bowlders, leaving the heavier ones isolated and prominent. To be able to remove more of the auriferous gravel, these large bowlders must be disposed of. They vary from two feet to four or five in diameter. When the stream is turned off, they are clean but wet. Masses of tenacious pipe clay must also be broken up before the giant can master them. This is generally done by blasting. The work gives employment to a large number of men, and makes a market for explosives, steel for drills, etc. Bowlder blasting, as it is called, is an important item in the expenses of a hydraulic mine. There is no operation in the working of a mine of this character which requires more care and system. Were this not observed, accidents would be frequent, which are now very uncommon.

A description of the operation in one mine will serve for all, as the system is much the same. At the North Bloomfield mine I saw forty men sent out immediately after the streams were turned to an unwashed area. The men commenced drilling, some single and some double. By this is meant, that in some cases two men were required to drill a single hole, one holding the drill, and the other striking with a heavy sledge. In others, when the hole was shallow and the bowlders soft, one operator both held the drill and struck. In the pipe clay masses, holes were bored with augers. In a short time one hundred and eighty holes were drilled, and the men congregated at the blacksmith shop in a body. Here the powder-man met them and served out cartridges and fuse equivalent to the number of holes drilled by each. With these the men quickly charged the drill holes and returned to the shop, where forty iron rods were heating, one end being redhot, while the other was cold. At a signal, each man took a rod from the fire and ran quickly to his post, all holding their rods aloft to show that they were ready. At a second signal, each man fired his fuses and ran to a position of safety provided for the purpose. One hundred and eighty explosions quickly followed, which sounded like the discharge of a park of artillery, and the air was filled with flying fragments. The average number of shots fired is 200, but as many as 240 have sometimes been discharged in a single operation. The blasting generally takes place at noon, after which the men go to dinner, and all the streams are turned on to wash away the debris. When the men turn to again, a new set of bowlders are exposed, and the drilling and blasting is repeated.

In some mines the fuses are lighted by candles. A little mud shelter is built up around each fuse, and a candle end, not more than an inch long, is lighted and set beside the fuse, but not too near. At a signal, a workman pushes the lighted candle under the end of the fuse, and quickly passes to another. Each man lights from three to five, as the case may be. The place of shelter mentioned is a block house, built of worn out paving blocks, and is strong enough to resist any fragment likely to fall upon it. "Bulldozing bowlders" is a term used in some of the mines when a giant cartridge is laid on the top of the bowlder without drilling, covered with a ball of wet clay, and fired. At Blue Tent this plan is common. At this mine one man charges all the drill holes.

BANK BLASTING.

This subject has been so thoroughly treated by Dr. Degroot, in his paper, that but little can be said in addition. At the Amador gravel mines, in packing tunnels in bank blasting, the Superintendent, Mr. Bluxome, after the powder is placed, builds up a stone wall, and then sets a line of men with nail kegs filled with loose earth. These are passed in, along the line, emptied, and the earth firmly packed and tamped against the wall. A small trench is cut in the bottom of the tunnel, for the escape of water, which is covered with boards, and packed over.

The following interesting details are by Mr. A. J. Bowie:

BLASTING.

Where the ground is very hard, recourse is had to blasting. For this purpose a small powder drift is run in on the bottom, from the face of the bank, a given distance, proportionate to the ground to be blasted. From the end of the straight drift a cross drift, forming a T, is driven. For example, in hard cement, like that at Smartsville, with an eighty foot bank, in a case where the ground is ordinarily bound, a drift is run in at the bottom of the bank, say eighty-five feet long; at the end of it, cross drifts are run out, respectively forty-five feet in length. Forty feet from the face of the bank two similar cross drifts are also driven. From the ends and center of each cross drift, two small "lifters," as they are called, are driven at right angles, extending respectively half way between the cross drifts and the face of the bank. These places are then filled with powder, which, in such ground as is in that locality, would require from 450 to 500 kegs. The heads of several of the kegs being removed, the main drift is tamped and the powder is exploded by means of an electric battery or fuse. Occasionally, in large blasts, several cross drifts are required, and in such cases it is customary to fire the powder simultanoously in several different places by electricity. The quantity of powder used is determined by the position, character, and height of the bank, a sufficient quantity only being taken to shatter it.

In some places, with lighter material, 200 or 300 kegs of powder will easily do the work that 500 or 600 barely accomplishes in heavy cement. At Blue Point, a blast of 2,000 kegs was exploded. At the Enterprise mine, 250-foot banks, a blast of 1,700 kegs was fired. The powder is of the ordinary blasting quality. For destroying large pieces of lava, pipe clay, bowlders, stumps of trees, giant powder cartridges are found very efficient.

It is customary, in certain districts, to wash off the top or lighter gravel and subsequently blast the bottom cement. For this purpose, shafts, fifteen to twenty feet deep, as may be demanded, are sunk, and a small chamber is excavated in the bottom of them; the chamber is charged with five or six kegs of powder, tamped, and then exploded by electricity. Undoubtedly there is a great waste of powder in bank blasting, and the subject is worthy of investigation with a view to future improvement in this particular. In blasting, it is desirable to thoroughly shatter the material, *i. e.*, separating rock and cement so as to facilitate its washing, thus insuring the earliest separation of the gold by enabling the bulk of the precious metal to come in immediate contact with the quicksilver in the head of the sluices, and affording every opportunity for the most complete scouring and securing of the eroded gold particles.

The following method of bank blasting has been found to give excellent results with banks from fifty to one hundred and twenty-five high, such as are generally encountered in hydraulic mining, and likewise in cement gravel of ordinary tenacity. In the absence of more definite knowledge on the subject its adoption can be recommended.

The main drift should be run in a distance two thirds the height of the bank to be blasted. The cross-drifts from the end of the main drift should be driven parallel with the face of the bank, and their lengths determined by the extent of the ground which is to be blasted. A single T is all that is necessary. The amount of powder required for charging the drift is from one half to two thirds of a keg of powder, minimum quantity, per 1,000 cubic feet of ground covered by the drifts—*i. e.*, height of bank × length of cross-drifts × length of main drift = cubic contents. The quantity of powder used must depend on and vary with the position of the bank and character of the gravel.

Late experiments made with Judson powder, applied as above directed, has given good results, and, though not definitely determined, the indications at present are that the use of this new explosive will be a great saving in the costs of bank blasting.

The shattering effects of powder used in the manner and proportion already described have been roughly estimated from the appearance of the ground subsequently washed at from 225 to 230 cubic feet of ground shattered per pound of powder exploded.

HYDRAULIC ELEVATOR.

The hydraulic elevator has been mentioned by Dr. DeGroot in his paper, but the following additional descriptions from the circulars of Joshua Hendy, who is engaged in their manufacture, will be found interesting and instructive:

In almost every mining region deposits of auriferous gravel and sand exist which have not hitherto been made available, simply because no efficient system or apparatus has been devised for working them economically and profitably, until the hydraulic gravel elevator was invented. In many instances the upper stratum has been sluiced off by existing methods and appliances; but the expense of handling, removing and washing the material at greater depths became so excessive that the deposits were necessarily abandoned even in the face of the well-known fact that the richest and largest yield of gold existed in the strata of gravel lying nearest the bedrock.

Many valuable and extensive auriferous deposits are found in basins and flats and lying along creeks, far too low to be under-run by bedrock tunnels, open cuts or drains, even at any cost, and the only method by which they have been hitherto worked has been by the laborious use of shovels and wheelbarrows, whims and derricks; and requiring, in many instances, the expensive use of engines, pumps and other machinery, to free the pits or excavations from water while mining was being carried on. In other cases, creeks and rivers have been wing-dammed, turned and flumed, the sipage water pumped out, and the auriferous sand and gravel removed by the old method of the shovel and wheelbarrow.

To overcome these difficulties, Wilford A. Rodgers of Sacramento County, devised a machine, for which he obtained letters patent January 9, 1872, which rendered it possible to mine these deposits with advantage and profit. In December, 1876, letters patent were also issued to G. W. Cranston for a somewhat similar device, and intended to effect the same purpose. These machines dispense entirely with the use of shovels and wheelbarrows, and the costly pharaphernalia of pumping machinery, and deposits topographically situated as those described with but a shallow fall or dump ground can now be worked as easily and profitably as those having natural outlets for sluicing away the debris.

The principle upon which the operation of these hydraulic gravel elevators is based is the simple fact, which is well known by hydraulic miners, that water and gravel can be driven up hill by hydraulic force, and that in a flume it is only necessary to give the impelling water more velocity to make it carry more earth or gravel before it. Miners, to accomplish this, give their flumes more grade. It is, therefore, only necessary to give water more velocity than it has through an ordinary flume to make it acquire sufficient force to carry gravel up an inclined plane. This fact suggested the construction of a form of machine which should so direct and confine the hydraulic inherent force of a stream of water as to impel before its power masses of earth or gravel or other heavy material.

These machines are simple in their construction, having neither belts, wheels, pulleys, valves nor buckets, in fact nothing to need repair and nothing complicated. They can be run by any one who can run a hydraulic mine. They sluice water and gravel up hill; work deposits that have only a shallow fall or dump; save the heavy expense of driving bedrock tunnels, open cuts or drains; sluice gravel of any dimensions that will pass through a flume; and drain all surplus water flowing from the gravel or on the bedrock; work as well as flumes having ten or twelve inches grade, and will handle as much gravel in proportion to the water used.

Their construction consists of an iron pipe having a horizontal ground section and pipe leading therefrom upward at an angle of forty-five degrees at an ordinary open flume lying above and extending beyond the pit, and into which the water and material forced through the pipe is discharged. This horizontal or ground section is constructed with an open end back of, or behind the entrance of the pipe into which the hydraulic nozzle is directed. The open end of the ground section is concave in shape, or a lower half section of the pipe flaring outward and into which the gravel is sluiced or washed by small outside hydraulic giants, through a bedrock flume leading to the Elevator throat or entrance; which is set below the surface of the bedrock as deep as possible, whence it is taken up by the stream from the hydraulic nozzle fixed at the entrance of the ascending pipe, which, impinging upon the gravel, earth or other heavy material forced into the entrance from behind, impels it forward and upward through the pipe to its point of discharge into the open flume above the pit or excavation, whence it is carried away by a line of sluice boxes to a final point of discharge.

Confined, as the material is, within a tight iron pipe, it is necessarily impelled forward with the velocity of the stream itself, and as each particle of gravel or other material is directly acted upon by the full force of this stream, it is necessarily considerably pulverized by this action as well as by the friction along the pipe in its ascent, and this disintegration is so thorough and considerable that long and expensive outer flumes leading away from the pipe discharge are rendered unnecessary.

From the impinging and frictional action of the water and gravel, it is evident that the greatest amount of wear will be upon the ground section and at the point of curvature of the pipe, and that this wear will be greater on its under section; consequently, the ground section and curved portion of the pipe are constructed in half sections, an upper and lower, with a flange turned out on each side, so that the two can be bolted together, and the lower half being worn can be replaced without trouble. In order to withstand this wear the lower half section is made of the best white or chilled iron.

These machines can be made of any capacity, and will handle any head of water used in hydraulic mining.

In operating the gravel elevator the primary object is, of course, to have it perform all the work of which it is capable, and as it requires no more power to raise a pound of gravel than to raise a pound of water, it should be the endeavor to pipe as much gravel towards and into its entrance as is possible, as it can rarely be overloaded. It must be borne in mind that it costs as much time and money to run water through the elevator pipe as it does earth or gravel, and it requires equally as much power to raise the one as the other. When the elevator is properly and advantageously set and operated, the amount of material which can be raised or impelled through the pipe is governed and limited only by the volume and consequent capacity of the water to carry the material through the outer discharge flume toward the dump.

In ordering these machines, the following data must be furnished, in order to determine the proper size to be constructed:

First—The depth of the gravel deposit, *i. e.*, from surface to bedrock, and the height from bedrock to the outer flume into which the elevator is to discharge.

Second—The available head or fall of water at point of operations.

Third—The volume or available supply of water in miner's inches.

It is estimated that 100 feet of hydraulic pressure will lift ten feet high; and as high pressure works better than low pressure, 200 feet of pressure will lift twenty feet high better than 100 feet will lift ten feet; or whilst 100 feet of pressure will only lift ten feet, 200 feet will lift twenty-two feet, and 300 feet forty feet. Therefore, with an available head of 300 feet, the hydraulic gravel elevator will wash any deposit forty feet in depth.

It will be observed, that since the earth, gravel, or other heavy material, which passes through the elevator pipe, necessarily occupies a certain portion of its space, and displaces a proportionate amount of water, that, therefore, the volume of water required to impel the gravel, etc., forward through the pipe will not be equal to the capacity of the pipe, that, in fact, not more than one half of such will be used, and that the remainder can be utilized in the mine through the hydraulic nozzles in driving the material towards and into the elevator.

These elevators are built of any required dimensions and capacities, and many improvements have recently been introduced into their construction, which makes the form now manufactured superior in every respect to those which have heretofore been used. These improvements consist in having a larger opening of the pipe at the ground section entrance, which diverges, or is contracted at the upper end of the section, thus contracting the space through which the material must pass, and permitting a more direct action or impingment of the stream of water upon it; also in giving a more gradual inclination or upward grade of the pipe toward its connection with the outer discharge flume, thereby obviating in a large degree the amount of friction encountered in the machines before constructed, the radius of the curvature of the pipe being greater; and further, by increasing the size of the discharge opening of the pipe gradually as it approaches the outer open flume, thereby preventing an excessive velocity of discharge, and consequently securing, by diffusing the material over a larger surface, a more certain and quicker settling of the metallic particles to the bottom of the flume.

These machines are in successful operation in the following places, viz: at Fiddletown, Amador County; at Pino, Placer County; at Forbestown, Butte County, California; at Canyon Creek, and at Waldo, Josephine County, Oregon.

Testimonials have been received from the managers of these several hydraulic properties, asserting that in every case these elevators do their intended work thoroughly; that they can be economically operated, and that they have fulfilled the expectations of the purchasers in enabling them to successfully work shallow auriferous gravel deposits.

At the property of the Yreka Creek Gold Mining Company, situated near Hawkinsville, in Siskiyou County, an elevator of the new form has been introduced, and it has proved to be superior to any yet constructed; a head of 266 feet of water is now elevating through a 16-inch machine, thirty-five feet three inches, and its capacity of lift is greater than that.

An examination of the practical operation of these gravel elevators is invited and desired at either of the places above designated. Such an examination, and a general and thorough understanding of their practical work and use, will undoubtedly lead to the opening of many deposits of gravel throughout this and other mineral States, which, though known to be rich, lie abandoned for the lack of the general knowledge that a machine exists by which these deposits may be economically and profitably mined, with but a comparatively small outlay of money for the cost of the machine.

It is found difficult, in some cases, to get the elevator down to the proper level to work the mine; and also, in case of accidents, the elevator entrance becomes covered with water so deep that it is difficult to get at it for the purpose of repairing. In such cases the use of the hydraulic water-lifting machine will be found to be of great advantage. It can also be used in certain drift mining, and in places where it will not pay to use the large machines, and work all of the material from the top. The machine works on precisely the same principle as the hydraulic elevator, but is not constructed or intended for hydraulic mining. It is intended to work in perpendicular shafts or sumps, but can be made to lift at almost any angle, and can be connected at almost any angle with the hydraulic pipe. It has two flexible or swivel joints, which allow the machine to be set in almost any position. When used in combination with the elevator, as a sump or drain, the machine is generally placed at the bottom of the elevator pit, somewhat lower than where the elevator is situated, so as to drain everything into it; and it can be driven by a branch pipe taken from the main pipe that drives the elevator, and is fitted with a cut-off or gate, to shut off the water when not in use.

THE HYDRAULIC BATTERY.

This idea originated in the year 1874 with Jasper O. Farrell, of San Francisco. It was to project against the bank the usual hydraulic stream, the force of which was to be augmented by bowlders fed into the iron pipe at the head. The effect was remarkable; it was however abandoned, as it was found to be unsafe in its use.

BEDROCKS AND GRAVELS.

The bedrocks and gravels of the hydraulic mines are a very interesting study—at the present time but little is known of them. At the Polar Star Mine, in Placer County, the bedrock is sedimentary and highly metamorphic. It has evidently been at one time soft mud, and shows obscure traces of stratification.

At Chalk Bluffs, in Nevada County, the bedrock is generally slate with edges upturned; the angle, if any, being nearly vertical. Great quantities of silicified wood, in many beautiful varieties, and whole trees changed to lignite, are found in these mines. There is a peculiarity here seen which is somewhat noticeable elsewhere. The formation uncovered by washing is crumbling or "slacking," as it is expressed by the miners; that is to say, the bedrocks and some of the bowlders which when first exposed were strongly coherent, have now fallen to powder, or are so soft that they can be easily crushed by the hand. Mr. Robinson has alluded to this in his paper, and shown that gold may in a short time be set free, that would at the time of washing escape all gold-saving apparatus, for the reason that it was protected by being imbedded in cemented gravel.

At the Manzanita Mine, near Nevada City, Nevada County, the bedrock is a decomposing granite. A sample brought to the State Museum, and numbered 3408 in the catalogue, in a few months fell almost wholly to a powder. When the rock was first exposed it was quite hard. There are found on the bedrock some dark-colored bowlders, much quartz sand, and some magnetic sand. The slickens from this mine contain mica scales, resulting from the decomposition of the granite bedrock. A great deal of work has been done at the Manzanita with little water and small head.

At the Milton mine, Nevada County, at the end of the main sluice, slate crops out—No. 3407 of the museum catalogue. I did not visit the workings of the Milton, but was informed that the bedrock was of a similar character. At Sweetland Creek, where a large area is exposed, the bedrock is a similar slate. At this locality copper shales and pyrolusite are found in considerable quantities.

In the bedrocks of the Malakoff Mines, North Bloomfield, and in the American Mine, both in Nevada County, may be seen pot holes, so called, which are the strongest possible evidence that powerful streams of water flowed over them, which continued for a long period of time prior to the deposition of the hundreds of feet of detritus which afterwards filled the channels to the present surface. This may be regarded as an argument in favor of the theory advanced by some observers to the effect that ancient river beds were filled by some sudden flood, or succession of floods, which gathered the bowlders from a wide area and deposited them within a comparatively short time in the channels as we now find them. There are other facts which sustain the same theory. If the observer stands on the bedrock of a deep hydraulic mine, and looks at the nearly vertical banks, he will notice that the formation is stratified; that the stratification is very irregular and has the appearance of having been deposited by installments, each seeming to record a single flood, or, at least, a period of similar conditions followed by another seen to be distinct from the last, and so repeated to the surface. There is no disputing the fact that a certain long period of quiet must have prevailed in the ancient river bed, during which the rushing waters caused bowlders to move in a depression until a pot hole ten feet deep, more or less, was worn. Any sudden deposition occurring would have buried the grinding bowlders below the action of the stream.

In the Malakoff Mine there is a false bedrock which, for a time, was supposed to be the true; it has all the appearance of the true. By accident, it was discovered that bowlders lay beneath. The upper rock was blasted away, and the under stratum of gravel worked. On the false bedrock, as well as on the true, water-worn surfaces were found, showing that the same condition of things existed at two different periods. On the lower bedrock, cement very compact and indurated may be seen plastered on the rocks, still so hard that, in blasting, the bedrock is more easily fractured than the cement. The bowlders in this mine are generally varieties of diorite and porphyry, with but little quartz.

The bedrock is undoubtedly the source of the gold in the gravels. The solfataric theory of the filling of fissures in the surface rocks of the earth is now generally admitted, and may be stated, in general terms, as follows:

An accidental crack, or fissure, in the earth's surface is caused by upheaval, earthquake, plication, or other manifestation of contraction, resulting from the gradual cooling of the planet. The elevation of mountains, caused by contraction of the earth's crust, was illustrated in a remarkable manner at the International Geological Congress, held at Paris in the latter part of August, and early in September, 1878. A common child's balloon, of indiarubber, was shown, which had been coated with wax; as the gas slowly escaped, the contraction caused the wax to rise, in certain parts, in ridges, which had a strong resemblance to mountain chains. I have repeated the experiment, in San Francisco, with similar results. It is easy to realize that such contraction should cause a tension in a sphere as large as the earth, and, on the rocks yielding to such a pressure, cracks would be produced. The contraction would not only cause fissures, greater or less in extent and magnitude, but the pressure, changed to heat, would produce volcanic phenomena, including hot springs. When a fissure was made, the hot water, now a stronger mineral solvent, would not only take up matter in solution, but would act as a common carrier, bringing together chemical substances; some having an affinity, while others were antagonistic. A sort of natural chemical laboratory would thus be established, causing endless changes, and resulting in the gradual filling of the vein with such elements and compounds as were within the reach of the collecting forces.

It must be clear that no gold could by any possibility be deposited in a mineral vein, unless that metal existed somewhere in the rocks within the influence of the local chemical action. This would be true of all the other metals and minerals. In all parts of the earth's surface veins have been filled, are being filled, and will be filled in the future; but if the minerals deposited are valueless, they pass without our notice. In countries where gold, silver, and other desirable minerals are found, nature has simply collected those accidentally disseminated through the rocks, and condensed them in the mineral veins, where we discover and extract them. In considering this subject, no account must be taken of time, for these changes are slow. A vein may be filled, the surface denuded, and the metals scattered, oxidized, and combined with others scores of times; new fissures formed, and the metals, to a certain extent, collected again and again, and deposited in new forms.

The phenomena mentioned may at the present time be observed in California and Nevada, in active progress at Steamboat Springs, Nevada; at the Geysers; at the Mud Volcanoes, in San Diego County; in Coso District, Inyo County; at the Redington Quicksilver mine, Lake County; at Sulphur Creek, Colusa County; at Sulphur Bank, Lake County; in the Comstock vein, Nevada; in the bubbling gases arising from the bed of Clear Lake; at Etna Springs, Lake County; and other localities. At some future time these facts will be more carefully collated and published. Dr. Oxland, Professor Joseph Le Conte, Professor J. D. Whitney, and other writers in our own State and many other lands, have called attention to these phenomena.

This interesting subject is mentioned here in this general way to show that the gold in our gravels is derived from the bedrocks, and probably not from outside sources. The quartz veins in metamorphic rocks, called in California "bedrocks," for the reason that the auriferous gravels lie on them as on a bed, were broken and worn by the erosive force of the ancient rivers, by glaciers, and by forces lately noticed and yet to be mentioned. The smaller fragments were crushed to sand, while the larger became the quartz bowlders so common in the hydraulic mines. In this disintegration process, gold in quartz veins was set free, while other metals, as lead, iron, copper, and zinc, yielding to the action of the elements, changed to compounds, and were lost to view. Ice very probably had much to do with the disintegration of the rocks in ancient times. Some phenomena have been observed which cannot in any other way be explained.

To show that material changes may take place in a short time, and that chemical forces are ever active, a few examples may be mentioned that have come within my own observation. In the case in the State Museum devoted to the lead ores of California, an open dish containing litharge was placed among other specimens intended to illustrate the economic uses of lead. The litharge has become blackened, which can only be explained by assuming certain chemical changes to have taken place within the glass case. Some of the galena has probably become slightly decomposed, and a small quantity of the lead oxidized, at the expense of water present in the atmosphere, and the sulphur taken the equivalent of hydrogen, forming hydrosulphuric acid, which being volatile, has passed to the litharge and produced a sulphide of lead on the surface, which, being black, the chemical change has become apparent to the eye. This has occurred within a few months.

Another metamorphosis took place in a drawer in my private collection. A fine piece of chloride of silver lay in a shallow tray of tinned iron, which had been painted black with a varnish of shellac in alcohol. By some means the varnish became broken and the iron edge exposed; the specimen had also accidentally slid over and lay partly resting on the exposed edge. Some time, several months, passed during which I had not opened that special drawer; when I did so I noticed a change in the specimen, and a close examination showed that the cerargyrite had changed to pure silver. A slight exchange of elements had taken place between the silver chloride and the iron, and sesquichloride of iron had formed in small quantity, which, being delequescent, attracted moisture from the atmosphere, increasing the chemical action, until a complete change took place, an equivalent of the iron combining with the chlorine, for which it has a greater affinity, leaving the silver in a metallic state. Both slate and shale are, no doubt, sedimentary mud or silt, which, from great age, have become indurated and in most part were formed at the bottom of the sea. The fossils contained in them are conclusive evidence of this. Natural forces have bent and warped the strata until they have become plicated like the leaves of a book, or a pile of writing paper pressed laterally. In slate quarries lines of stratification of various colors may be seen marking the different periods of deposit; the lines of cleavage lie generally in a certain direction, which is called the strike; the inclination is called the dip; they were all laid in horizontal strata. Slate is altered shale; instead of cleaving in the plane of stratification, as shale invariably does, it now divides at an angle with the natural deposition. The new lines of cleavage are called cleavage planes. The line of strike in the slates is almost invariably parallel to the trend of the mountains, and the upheaval in the surrounding country, from which may be inferred that some lateral pressure has bent the strata and caused at the same time the slaty cleavage.

To prove this, Mr. Sorby, of London, made some interesting and conclusive experiments bearing on this subjeet. He subjected a portion of clay without cleavage or stratification to very great pressure. The original mass contained scales of oxide of iron, which were distributed throughout the clay without regularity. The clay was reduced by the pressure to half its volume. The result of these experiments was the development of certain singular phenomena. The scales of iron oxide had arranged themselves in parallel lines, and a slaty cleavage was now apparent, and singularly, the cleavage planes were at right angles with the pressure applied. Professor Tyndall has shown that pure white wax can be made to cleave into parallel scales if sufficient pressure is applied. Were these experiments not sufficient to prove that slate, unlike shale, has been under great pressure, other facts may be stated.

In the silurian slates of Europe, the imbedded fossils are frequently distorted, and the elongation is always in the direction of the cleavage planes, showing that the movement of particles which caused the lamination was in the line of least resistance, or at right angles with the pressure. When there are no fossils present, small gravel and pebbles are found to be arranged like the iron scales in Mr. Sorby's experiment, with the longest axis in the direction of the dip. When neither fossils nor large particles are present, a thin slice placed under the microscope will show the finest particles and accidental scales of mica arranged in the same manner. It may be assumed that any fine grained sedimentary rock submitted to sufficient pressure by the forces of nature, will develop the same slaty structure.

GENESIS OF AURIFEROUS GRAVELS.

I have reason to believe that we have been generally mistaken as to the genesis of the auriferous gravels in the beds of ancient rivers; for river beds they are, without a reasonable doubt. But the theory that these immense bodies of gravel were deposited by a great flood, by a series of floods, or by long deposition by the rivers themselves, does not account for the gold in them. The microscope seems to show that they are not river sand at all, and have never been far removed from the place that gave them birth. I have examined samples from many localities, including some of the most noted hydraulic mines in the State, and the result is invariably the same. The sand grains are all sharp and angular, and not at all worn as are those from the sea-shore, the great Colorado desert, the agricultural soils, and the beds of the present rivers. To verify these results, I pulverized quartz on an iron slab to different degrees of fineness, and examined it under the microscope, finding it identical with the sands from the gravels of the gold placers. Many mechanical analyses have been made in the laboratory of the Mining Bureau; a few of the most interesting of which are given in these papers. Others will be published in the future.

Mechanical, Microscopical, and Semi-chemical Analysis of Gravel from the Nevada Hydraulic Mine, Chalk Bluffs, Nevada County, California.

	Per Cent.	Per Cent. of Quartz.
Portion "A," zircon sand	00.01	
Portion "B," large pebbles	39.80	89
Portion "C," coarse gravel	29.80	63
Portion "D," remained on No. 10 sieve	7.67	57
Portion "E," remained on No. 20 sieve	1.03	59
Portion "F," remained on No. 40 sieve	3.13	78
Portion "G," remained on No. 60 sieve	3.90	86
Portion "H," remained on No. 80 sieve	1.53	80
Portion "K," remained on No. 100 sieve	1.37	82
Portion "L," passed No. 100 sieve	1.47	72
Portion "M," slickens	10.29	Nearly all
Total	100.00	

This sample was taken from a pillar near the surface, and is considered a fair sample of the gravel worked in the mine for the last fifteen years. A proper reduction for the large bowlders which are plentiful in the mine, if it could be calculated, would reduce the percentages of all the parts obtained in this analysis.

After separation of the larger pebbles and the coarser gravel, the finer portion was carefully washed; no gold was found, but a very heavy grayish sand, portion "A" remained on the batea. This was examined microscopically and found to be composed of some black non-magnetic particles, a white mineral resembling quartz, a few red crystals, fewer white ones resembling rough diamonds, a small portion of magnetic sand, and an abundance of beautiful crystallized zircons. The red crystals were obscure, being somewhat worn on the edges. Those thought to be diamonds had that peculiar stearine luster and appearance common to rough diamonds, and were extremely brilliant to reflected light. A whitish substance floated on the water in which the dirt was washed; this, placed under the microscope, was found to be pine sawdust, and being foreign, was not weighed or estimated.

Portion "B" was large pebbles, the largest being three inches in diameter, eighty-nine per cent. of which were quartz; they were all rounded as if water-worn.

Portion "C" was coarse gravel, between half an inch and one inch in diameter. It contained sixty-three per cent. of quartz, nearly all the gravel was rounded.

"D" remained on a No. 10 sieve after removing "B" and "C." It contained fifty-seven per cent. of quartz.

The other portions consisted largely of quartz, nearly all the grains were angular, and not in the slightest degree worn. No observant person can study these sands under the microscope without feeling that he is looking at the ruins of the rocks. There can be no doubt that each little grain owes its present condition to some powerful cause which has acted on larger rock fragments or formation with sudden force, and that the sands are not the result of slow disintegration of the crystalline rocks; this is a very interesting discovery. The finest particles in the slickens that float to Sacramento, and which do not settle in still water for hours, are each a sharp, angular fragment of quartz, a flake of mica, or a bit of slate, and resembling in every particular, except size, the coarser parts.

The waters of the Rhone enter the Lake of Geneva milky and opalescent, the same water flowing from the lower end is as pure as crystal. Here is an example of natural slickens, ground from the surface of ice-covered rocks, which are dissected by the keen tooth of the sluggish, but ever working glacier.

Prof. Joseph LeConte, in a paper read before the National Academy of Sciences, October 20, 1879, mentions sub-angular fragments in the auriferous gravels, and their resemblance to true till or ground moraine; if he had examined the finer particles microscopically he would have found the resemblance still more marked.

It cannot be that these sands result from the disintegration of sedimentary rock, for if this were the case the grains of quartz could not be so universally angular. Some of the larger pebbles are secondary, but in the finer parts nearly all traces of these rocks are lost. An occasional flake only of mica remains to show that crystalline rocks yielded to the comminution which produced the fine sand—if it is proper to call it sand—we see lying on the glass slide under the microscope. The soft rocks seem to have offered but slight resistance to the unknown forces, and being crushed to an impalpable mud have been washed away centuries ago. The zircons and supposed diamonds being much harder, resisted, and have remained intact, to the crushing power which reduced the granites and other crystalline rocks to an uneven powder.

Observations made in studying this very interesting subject seem to strengthen the opinions of the advocates of the theory of extensive, intermittent, and almost universal glacial action on the earth's surface, no theory I am familiar with so perfectly accounts for the present condition of this sand. I find the resemblance between the finer sands of this specimen and the diatomaceous earths of the State so marked that I am inclined to trace a connection between them. After making a comparison under the microscope I returned to the former and made a critical and long continued search for organic forms, feeling to a certain extent disappointed when I found none, yet the resemblance is so striking that it would seem almost proved that the hydraulic gravels and the diatomaceous earths have the same common origin; the latter being brought down by the streams and deposited in some quiet ancient lake, in which diatoms living and dying left their tiny skeletons in the slowly deposited silt. It is well known that certain strata in the diatomaceous earths contain these interesting forms in greater quantities and in more specific varieties than they are found in others, which would seem to indicate that they were deposited in different geological eras, or at least at different intervals of time.

It is probable that the diatoms derived the silica required for their shells from quartz held in suspense or solution in water. Thinking this over, another experiment was made which established still stronger evidence as to the similarity between the finer silts and the diatomaceous earths. A portion of the former was boiled in a silver dish with a strong solution of caustic potash. A large quantity of silica was dissolved, which proves that at least a portion of the silica had changed from its condition of quartz, and had assumed the nascent or soluble state. It is well known that diatomaceous earth is largely soluble in caustic alkalies, advantage being taken of it in the production of silicate of soda and potash on a large scale; and it is equally well known that quartz is only slightly acted on, except after being calcined, and under pressure. I am aware that finely powdered quartz, long heated with boiling potash lye, slowly changes to the soluble state and enters into solution. In this experiment the solution was immediate and copious.

Portion "M" was fine slickens which, being allowed to dry in a mass, became hard, and, broke with a fine grained conchoidal, fracture like lithomarge. Examined microscopically it had the general appearance of the others. There should be a distinction made between "mining debris" and "slickens." The former consists of bowlders and heavy particles which remain near the mines; the latter is finely divided silt, so light that it floats to a long distance, and only settles in stagnant water or in streams that move very slowly. All the stratified and many of the metamorphic rocks are natural slickens.

A chemical analysis of a typical sample of "slickens" taken from the American River, near Sacramento, was made by Mr. Edwin Booth, which gave the following result:

Water (H_2O) and organic matter	11.00
Silica ($Si\ O_2$)	58.36
Alumina (Al_2O_3)	15.52
Sesquioxide of Iron (Fe_2O_3)	10.04
Lime ($Ca\ O$)	1.83
Magnesia ($Mg\ O$)	1.30
Soda (Na_2O)	.10
Potassa (K_2O)	1.14
Sulphuric Acid ($S\ O_3$)	.79
Phosphoric Acid (P_2O_5)	.18
Specific gravity, 2.50.	100.26

ANALYSIS OF FOUR SAMPLES OF HYDRAULIC SANDS,

By Falkeneau & Reese.

Ingredients Found.	No. 1.—Sand from Gold Run Mine on bed-rock.	No. 2.—Sand from Gold Run Mine 180 feet above bedrock.	No. 3.—Sand taken 300 feet above junction of North and Middle Forks of American River.	No. 4.—Sand from American River 200 feet above junction with Sacramento.
Silica	80.50	66.90	90.05	70.00
Oxide of Iron	7.20	9.00	4.16	10.80
Oxide of Aluminum	3.80	12.30	3.00	9.20
Lime	1.27	None.	0.90	1.52
Oxide of Manganese	0.30	0.50	0.40	0.50
Magnesia	0.18	Traces.	Traces.	0.32
Potash	0.90	1.69	Traces.	1.71
Soda	Traces.	0.17	Traces.	0.90
Moisture at 100° "C"	1.48	6.02	0.76	2.24
Water Chemic. combined	3.30	3.32	0.56	2.80
Phosphoric Acid	Traces.	Traces.	Traces.	None.
Sulphuric Acid	Traces.	None.	Traces.	Traces.
Specific Gravity	2.580	2.31	2.66	2.60
Specific Gravity, (after washing).	2.584	2.46	-------------	-------------

The faces of the banks at the Polar star, as exposed by the mighty labor of the giant nozzle, are irregularly stratified from bedrock to surface, some parts stained with oxide of iron, and what is very remarkable, the bowlders, be they large or small, are all white quartz. At Gold Run, in the same county, the bowlders are diversified in character, being hornblende, porphyry, and diorite with some quartz. The bedrock is slaty, and in some parts shows a brecciated structure as if it had been plastic at some time like the serpentines. In the bedrock there are a multitude of very small quartz veins, and a conspicuous incrustation of alum forms on the rocky sides of the tunnels and open cuts.

The "blue channel" at this point is about 150 feet thick, extending from the bedrock upwards. The "red gravel" lies 300 feet in thickness above this.

From the Polar Star mine a sample of fifty pounds of gravel was taken from near the surface, which had never been disturbed by the hand of man, and submitted to a mechanical analysis with the following result:

"A," large pebbles	34.8425
"B," coarse gravel, one inch	6.8295
"C," coarse gravel, half inch	11.2012
"D," finer, No. 10 sieve	23.1420
"E," coarse sand, No. 20 sieve	8.0040
"F," finer, No. 40 sieve	8.7870
"G," finer, No. 60 sieve	3.4252
"H," very fine, passed No. 60 sieve	3.7545
"I," remained in batea	0.0141
Total	100.0000

The gravel was colored ochre yellow by oxide of iron, a great portion of which washed off with water. The large pebbles were, with one exception, quartz, with peculiar striations not due to mere water washing, but deeply grooved as held in a natural vice while another body moved against them, which seems to be a clear indication of glacial action; the exceptional pebble is serpentine. No noteworthy feature was observed in the microscopic examination of the fine gravels and sand, except the sharp and unworn angles and edges.

An examination of the portion left on the batea was unusually interesting. There were some dark colored and very heavy particles which proved to be battered bird shot; a few colors of gold were seen, with a considerable quantity of black particles, constituting about fifty per cent of the whole, but few of which were magnetic. There were, also, a few particles of hyalline quartz and much sharp angled quartz sand, but no zircons. As compared with dune sand, it was much less worn, the particles being nearly all angular and sharp; the black particles were less angular than those of the quartz. The gold was somewhat coated, the coating being white, like silica, but not to the extent common to much of the gold in the placers of the State.

Portion "H," as seen under the microscope, is composed of particles made up of exceedingly fine atoms, all of which are quartz, sharp and angular, and colored yellow by oxide of iron. Boiled in nitro-muriatic acid, and well washed, the quartz became pure white, and the acid solution gave a strong reaction for iron. It is easy to understand how such a deposit should form beds of yellow ochre when concentrated from sand and gravel by long continued action of water in motion.

PLACER GOLD.

Some years ago I read a paper before the Microscopical Society, which was reproduced in my first annual report, 1880, folio 39, on "Rusty Gold," giving the result of my experiments and observations up to that time. I have since continued the study of placer gold in this abnormal condition, which has led to the discovery of important facts bearing on the production of gold in California. For many months I have conducted a series of experiments in my private laboratory on placer gold from numerous localities in the State. I have also studied the behavior of gold in the presence of mercury under all conditions I could think of, the results of which have been carefully recorded.

When perfectly clean gold is exposed to the action of pure quicksilver it is instantly seized by the latter and coated with amalgam. The accident of gold being alloyed with other metals in nature does not impair its affinity for mercury, if the surface is made bright mechanically by filing or scraping. Much of the native gold found in placer mines, apparently clean, is slightly tarnished by the oxidizing or mineralizing of its alloy, in which case it amalgamates with difficulty. I have failed in every instance to find gold in quartz in this condition, although intelligent miners have informed me that they have sometimes observed it in their experience. A large proportion of the placer gold found in California is wholly or partly coated with silica, cemented by sesquioxide of iron, as stated in my former paper. When wholly coated it is perfectly inert to the action of mercury (one might as well put gold in a glass bottle and attempt to amalgamate it from the outside). When partly coated, the exposed parts become amalgamated, and to that extent only is the gold held by the mercury. If rusty gold is digested in hydrochloric acid the iron is dissolved, and a slight mechanical force then serves to detach the silica, when amalgamation takes place without difficulty. There is no hope of being able to free the gold from this coating during the few hours it is exposed to the forces employed in the well known hydraulic process. When clean gold amalgamates it does not become homogeneous, but the amalgam forms only on the surface. I have had a piece of placer gold in mercury, standing in my laboratory, for several months, during which time I have frequently triturated it—sometimes several times a day—and it is not yet dissolved; still, in pouring from one vessel to another, the mercury flows freely without showing the gold, but I can at any time fish it up with my finger. Gold so amalgamated could not, in the process of placer washing, escape from the mercury, but coated gold, under the same circumstances, will float on the surface of the quicksilver, and any slight force sufficient to overcome its specific gravity will detach it.

The coating of gold may be imitated, as found by experiment. A piece of pure gold, after annealing, was placed in pure mercury, and it instantly became amalgamated. Another portion, exactly similar, was hammered on a perfectly clean and polished anvil, with a polished hammer, and placed in mercury like the first. It became as quickly amalgamated. Pure quartz was then ground to a powder and sifted on the anvil in a thin stratum. A third piece of the same gold was then laid on the powdered quartz, struck several times with the hammer, turned over, placed on a different spot, and again hammered. The gold was then examined under the microscope, and seen to resemble the coated gold found in the placers, the quartz particles being imbedded in its surface. When placed in mercury, and allowed to remain for some time with frequent agitation, it floated on the surface, and seemed to be wholly unacted upon, but when placed under the microscope it was found that the mercury had attacked the gold through the small interstices, but only to a very limited extent. The gold was then placed on an iron slab, and gently rubbed with an iron muller, by which treatment it became more perfectly coated, and was now an exact imitation of the natural coated gold, minus the iron cement. In the natural coating of placer gold I consider the cementing to be a secondary process, and the sesquioxide of iron to result from decomposing pyrite, which was abundant in the quartz veins that yielded the gold.

Mr. Goodyear thinks, and with good reason, that vast quantities of gold lie under the great valleys of the State, between the Coast Ranges and the Sierras, which can never be recovered. It has been pretty generally established that the most productive portion of known quartz ledges lie comparatively near the surface; this being admitted, there is reason to believe that if the bedrocks below the present workings should become in time disintegrated, a smaller portion of gold would be set free.

Elaborate experiments have been made in Italy and elsewhere by grinding river stones of all colors and textures on grindstones, and by shaking them together in boxes, to estimate the time required and the force necessary to reduce them to their present rounded condition.

Paul Frisi, in his Treatise on Rivers and Torrents, and Guyliemani in a similar work, have recorded various experiments made with a view to prove or disprove theories prevalent in their time, as to the cause of rounded bowlders, pebbles, and sand found in rivers. The former wrote his celebrated treatise in 1762. They both assumed that the rivers in which the pebbles were found had imparted to them their spherical form, and found by experiment that, even if swept down the whole length of the stream, they could not possibly have become rounded to the extent shown in those found high up in the rivers, failing to account by experiment for the gravel and for the sands of the vast deserts of Tartary, Frisi came to the conclusion that they were created as such, in the following words:

As for myself, I am of the opinion that the rounded stones, gravel, and sands, are substances originally prepared by Nature and spread all over the globe; that stones rolling on the bed of a river may there receive a greater degree of polish, and sands may possibly become smaller, but that stones and gravels rubbing against each other, however great may be the force, can never be converted into sand.

When it is considered that this expression of opinion was made at a period when no person would dare question that the world was more than three thousand years old, and when the science of geology, as we now understand it, had no existence, the opinion was justifiable. In support of his conclusions, he states that in Holland and elsewhere, subterranean beds of sand and gravel are found so abundant and at so great a depth, that it was quite impossible they were worn or deposited by rivers. He calls attention also to the fact that hills and mountains consist largely of such beds.

Broken masses of granite, which consist largely of quartz, naturally weather into spherical bodies, and the forces of gravitation tend to produce globular forms. I have noticed, in several localities in California, large bowlders of granite in place, which were rounded by the slow scaling of the surface caused by frosts and rain, and have observed concavo-convex and large sized slabs still adhering loosely to the mass. When detached, a convex surface was left on the remaining part. All mineralogists know the property of quartz minerals to break with a conchoidal fracture. On the other hand, rocks which break into angular fragments are generally soft, and easily worn down by attrition with each other. On the Eastern slope of the Sierra Nevada Mountains, where there are no great rivers or torrents, a talus of vast extent may be seen lying against the foot of the mountain, composed wholly of angular fragments of metamorphic rocks. These deposits extend for hundreds of miles. They have often excited my wonder as to their origin. Still in the beds of the small mountain streams, in the near vicinity, the ubiquitous bowlder may be found. In truth, we must search beyond the present period of natural hydraulic forces for the solution of this enigma; but it may be assumed that bowlders have been ground under glaciers, and subjected, again and again, to the action of torrents and streams during countless ages, and will probably continue to be for as many ages to come. The zircon sands, described in this paper, may be regarded as a strong argument in favor of this conclusion. They were formed originally in the crystalline rocks, having been set free by disintegration. The same may be said of the magnetic sands seen in place in microscopic sections of crystalline rocks. The zircons have been subjected to the attrition which has rounded the bowlders and pebbles, and ground the granites to sand, but, being harder than their associates, have resisted the forces, and retain their sharp angles of crystallization most perfectly. Their great specific gravity has caused them to become concentrated.

I am indebted to J. W. Howland for the following description of a remarkable example of the origin of quartz bowlders:

At a point near the American House, four miles from Laporte, Plumas County, there are two very large quartz ledges running nearly northeast and southwest. One is sixty and the other eighty feet wide. They are separated by a stratum of slate, and all dip to the south at an angle of about sixty-five degrees. On the southeast side, and extending for a considerable distance, the surface is covered with detached quartz bowlders, while on the other side there are none. It is clear that some force more powerful than water has swept across these ledges from the northwest, which has broken down the quartz, and ground it into gravel and small bowlders.

The following table of the principal minerals composing rocks, and their associates, which are likely to be found in placer mines, with relative hardness and specific gravity, will be interesting and instructive in this connection:

Name.	Hardness.	Specific Gravity.
Graphite	10	2.10
Talc	10	2.60
Gypsum	20	2.30
Chlorite	20	2.60
Gold	25	19.25
Serpentine	25 to 40	2.60
Mica	25	3.00
Calcite	30	2.70
Limestone	30	2.70
Barite	35	4.48
Dolomite	35	2.90
Fluor spar	40	3.10
Platinum	45	17.75
Pyroxene	55	3.20
Magnetite	55	5.00
Hornblende	55	3.00
Nephelite	55	2.50
Scapolite	55	2.60
Menaccanite	55	4.50
Leucite	60	2.50
Hematite	60	4.50
Cyanite	60	3.40
Feldspar, Orthoclase	65	2.50
Olivine	65	3.30
Epidote	65	3.00
Staurolite	70	3.50
Tourmaline	70	2.94
Feldspar, Albite	70	2.60
Quartz	70	2.60
Zircon	75	4.75
Diamond	100	3.50

Extracts from Mr. Bowie's paper:

It is not unfrequently stated that it is from the washing of the entire banks that the gold is to be expected, it being disseminated throughout the whole deposit. That deposits are or are not auriferous for their entire depth will not be discussed; but that gold is proportionately diffused throughout the detritus, so that it could all be considered as "pay," is denied by experience and facts, as proven in California and other parts of the world. It is owing to that circumstance that miners have coined the expression "pay dirt," which means that stratum or those strata which contain the bulk of the precious metal.

In some districts gold is found thirty to fifty feet above the bedrock in sufficiently paying quantities to hydraulic, and in some shallow banks gold is quite generally disseminated. Both at San Juan and North Bloomfield the gold is more or less scattered throughout the deep drift, and diggings near Forest Hill, Placer County, twenty to sixty feet above the bedrock, have yielded profits.

The top gravel of the channel deposit which passes through Columbia Hill, Nevada County, has, in several instances, been successfully washed. This is especially remarkable on account of the great depth of this deposit, which, from the explorations on Badger Hill and Grizzly Hill, is inferred to be 600 to 620 feet deep. With such facilities as would be afforded by a heavy grade, sufficient dump and cheap water deposits of this character consisting of a fine light quartz wash, containing no bowlders nor pipe-clay, though they contain an insignificant amount of gold per cubic yard, could be successfully worked by the hydraulic method.

Experience has proved, however, that the quantity of gold found in "top gravel" is insufficient to warrant any large investment based solely on its value. Under exceptional conditions and circumstances the upper strata have, in some cases, yielded handsome returns, but on the whole the general results have been anything but fortunate.

In the Patricksville Light Claim, Stanislaus County, California, the pay stratum is six or seven feet thick and adjoins the bedrock. The gold is concentrated in this gravel deposit as long as there are sand strata in the bank, but with their disappearance it becomes diffused throughout the detritus. Whilst working this claim a large hole in the bedrock twenty-five feet deep was bottomed. The hole was filled with gravel, but no pay was obtained. The pay stratum was found to be on a level with, and a continuation of, the pay stratum of the rest of the claim. On the other hand, at the Chesnau and French Hill claims, whenever these hollows are found, a large yield of gold is invariably obtained.

The gold alluvia found near and along the banks of the Tuolumne River, Stanislaus County, present some striking examples of the distribution of the precious metal. The pay dirt in the Chesnau claim is confined to within six feet of the bedrock, whilst in the Sicard claim, situated about 600 feet south of it and across a ravine, with banks from twenty to forty feet high, the gold is more generally disseminated as long as there are no sand strata, but whenever the latter appear the pay is confined to near the bedrock.

That the beds of the auriferous gravels are channels of ancient rivers seems to be proved by an examination of the surfaces exposed in the hydraulic mines, in which may be seen deep pot holes—before mentioned—worn by bowlders kept in violent and long-continued motion, the little deposits of magnetic sands under the lee of protecting bowlders, marks of eddies, and the fact that all flat bowlders on the bottom overlap like shingles on a house-top, the small ends being invariably down stream. That the channels were filled by the rivers themselves seems to be as clearly disproved by the fact that gold is distributed throughout the whole mass, from bedrock to surface, by the sharp angular sands, and by the coated gold. Water must have flowed in the ancient rivers comparatively free from obstruction for a long period before the deposition of the gravels to admit of the deep pot holes being worn in the hard rocks. From the examination of the hydraulic sands, it is fair to infer that the same force that crushed the rocks set the gold free, flattened the grains, and coated those which passed between the rocks and the grinding force, in a manner similar to that pursued in my experiment mentioned before.

A river is a natural channel to the sea, cut by water lifted to the level of the mountain tops by the sun, and its effect on the earth's surface is natural hydraulic mining, its labor being imitated by the hydraulic miner.

If we may assume from the character of the deposits, that the river beds were not filled by the rivers themselves, there is less reason to believe that the ancient streams were larger or more powerful than those of the present time. The present rivers, although they have cut immense cañons, have not deposited much detritus in their beds; but when it is understood that most of the California rivers flow in a narrow bed in the bottom of a V shaped cañon, the angles of which are from thirty to forty degrees, and that they have cut their channels down 2,000 feet or more, some idea of the work they have done may be gained, and we may well ask where this immense quantity of debris has been placed.

The California rivers of the present day are at times rushing torrents. When warm rains fall on melting snows, accumulated during a severe winter, they become swollen to a very great degree, but at their greatest height they are small as compared with the cañons through which they flow. At other times some of the most important rivers in the State become small streams in their mountain locality, while some of them dry up entirely.

In accepting the popular theory, there is reason to believe that at some early period there was a climate quite different from the one of which we are now so justly proud. Storms were presumably more violent and the rains more incessant, or at least far more abundant than at present. Yet, if we take no note of time, and assume only the same to have elapsed during which the Colorado cañon was cut, we may account for all the phenomena now observed in connection with this subject. The ancient rainfall may have been greater, or there were extreme seasons of storm, or sudden condensation, like the cloudbursts or waterspouts, so-called, still common in the arid regions, but either on a larger scale or of more frequent occurrence than at present, if the gravels are wholly fluviatile, as assumed by some. The phenomena which we consider cannot be laid to the work of the sea, for no traces of marine life are recorded on the rocks, which are singularly destitute of fossils. Nor can the filling of the channels be attributed wholly to glacial action, for the presence of the rounded bowlders remains to be accounted for.

A single waterspout will cut a deeper and wider channel in an hour than hydraulic mines will in years. In estimating the injury of lands caused by hydraulic mining, the natural action of California rivers is unjustly charged to the miners.

Some of the theories of the gravel channels have been elaborately treated by Dr. Degroot in his paper, and our mining literature is replete with them. But as the testimony collected is meager, we shall for the present be compelled to accept theories; but it is clearly the province of the Mining Bureau to collect facts bearing on this subject, and to make them known through its publications. With this view, specimens of the bedrocks, hydraulic gravels, tailings, and country rocks have been collected and placed in the State Museum. Others will be added, and in due course of time, sections for the microscope prepared, which, in conjunction with chemical analysis, are the only way their true character can be made known. These specimens will always be displayed for inspection and study by those specially interested.

Having to a certain extent speculated on the origin of the auriferous gravels, and given some of the most generally accepted theories, I call attention to certain facts which I have observed during a recent visit to drift and hydraulic mines in Butte County, and a reconnoissance of that locality generally.

On approaching Oroville from Marysville, there may be seen in an open cut of the road, a deposit of worn or rounded gravel, which is the outer margin of a vast area of the same gravel, which is, to a greater or less extent, auriferous. At the Miocene mine, now stopped by an injunction, a deep deposit is exposed which has been successfully worked for gold, the gathering of which has given employment to many men, and has added largely to the wealth of the State.

At Cherokee Flat, ten miles north, very extensive workings may be seen, with banks 430 feet high; being a curious succession of sedimentary deposits, from the finest silt to bowlders of immense size, capped in part with columnar basaltic lava. Under this deposit, which has all yielded largely of gold, there lies a stratum of the blue gravel which has added so much to the wealth of the world, and which still retains infinitely more than it has produced.

On the road from Oroville to Dogtown, or Magalia, as it is now called, the road lies generally in valleys which have been cut through this formation, leaving elevations known in California as "table mountains," which are invariably capped by lava. In crossing these valleys it will be noticed that the plains are covered with bowlders, varying in size from small pebbles to masses of considerable size; these have, without doubt, fallen from the higher elevations, and cannot have moved more than a few miles at most, for they are all of the basalt of the table mountains, which, geologically speaking, must be very young as compared with the formation underlying them. A close study of these bowlders will develop some striking features, bearing directly on the formation of the gravel deposits of California, which came to me like a revelation, and which cannot fail to interest any observer. All the fragments, be they large or small, have taken to a greater or less extent a rounded form, not by attrition, but by natural weathering; not only are the angles all removed or rounded, but the fragments falling from them, in many instances lying by their sides, are concave on the inner surface, leaving the remaining portion more or less globular, as in the case of the granite bowlders before mentioned, the basalt is uniform in structure, has no particular cleavage, and breaks with a tendency to form sharp angled fragments, yet the same rock, when exposed to the action of the elements for a long period, invariably weathers into rounded forms while lying on the surface of the ground, and not subjected to any special action of water above that of small winter streams and overflows. This discovery led to more careful examination, and I am convinced that this is a general law which bears equally on all rocks, including quartz, which being harder, resists longer, but ultimately yields to the invariable law, and its fragments become rounded bowlders far from rivers or rushing waters. When by accidental floods or changes in the course of streams bowlders fall into their beds, they become polished and smoothed. At Red Hill I actually saw quartz bowlders being thus formed, which without doubt, came from a prominent quartz vein within a few hundred feet of where they lay. Closely observing bowlders of every variety of rock which lie exposed in the placer and hydraulic mines, I found them all showing evidences of this law, and I collected concave scales which have been placed in the State Museum, where they will be preserved, and may be studied by those who may take an interest in this most interesting subject.

When I made the discovery, by the use of the microscope, that all of the sands in the hydraulic mines were angular, and not rounded by the action of water, as I expected to find them, I came to the conclusion that the river beds had not been filled by force of water, as was generally supposed, but that we must look for a new theory based on the new discovery. I naturally looked to ice as the agent, and attributed the filling of the beds and the disintegration of rocks, to the action of glaciers moving over the land. This view, while it would account for many of the phenomena, did not account for others; the rounded bowlders were a stumblingblock which could not be overcome, and their formation, by long continued action of water, could not be made to harmonize with the angular condition of the sands. With the glacier theory, also, it must be assumed that climatic conditions in the past must have been very different from now, of which we have no proof. When I discovered that the bowlders were probably formed long before they were deposited in the river beds and cañons of earlier times, a new light dawned upon my mind, and I began to think that the great lava flows might be the active agents in filling up the inequalities of the land, and that the bowlders already formed had been picked up by the flow or pushed forward by the approaching lava mass. This was a striking feature in the new theory, and only required the lava cold to be perfect. Soon after, I visited the Spring Valley Hydraulic mine, at Cherokee, here I found the formation cut down for 430 feet, exposing a gigantic section, from the lava cap of basalt to the bedrock, of syenite. Studying this section carefully, I noticed matter in the form of indurated mud, or semi-lava, in which were imbedded rounded bowlders, of a similar nature but of a different color, suggesting the idea that the former may have flowed, in a semi-liquid state, and gathered up the soft bowlders as it moved; this idea called to my mind what I had noticed with wonder in other localities.

At Picket Post, in Pinal County, Arizona, there is an immense formation of this character, which covers the country for many miles. I had the pleasure of visiting this locality, in company with Professor Cook, State Geologist of New Jersey, and we speculated as to the origin of the deposit. We noticed that the so-called lava partook more of the nature of plastic earth, or volcanic mud, and that it had a brecciated appearance, as if it had picked up bowlders of a similar but older formation. We noticed, imbedded, rounded bowlders, or pebbles of obsidian in the mass, for which we could not account.

On the borders of Mono Lake there is a lava flow which partakes of the compound character of true lava, and of volcanic mud, which, in a like manner, is filled with rounded bowlders of a different formation.

Before visiting the Cherokee mines, I had seen the Indian Spring drift mine, and followed the bedrock in the tunnel 1,730 feet, to a locality far below the lava, where, a short time before, the tusk of an elephant and tooth of a peccary had been found, now preserved in the State museum. I wondered that these gravel deposits were always of the same character and invariably capped with basalt, except where denuded by more recent geological forces, and sought in vain for a solution. I was exceedingly fortunate in having my attention called to phenomena, now in full action, which threw a new light on this subject.

From Cherokee I was invited by Mr. Louis Glass, Secretary of the company, to ride over the surface of the Table Mountains with him, and to visit the hydraulic mines in Morris Ravine, owned by the Hon. W. C. Hendricks. As we rode over the level lava plain, it became clear to me that a flow of lava had swept over the face of the land, filling up all the inequalities, and forming a level plain, cutting off at the same time all the outlets of the ancient streams, which immediately set about to cut new channels, and, in course of time, forced their way through the lava, forming, in time, the valleys before mentioned.

On reaching Morris Ravine, I witnessed a strange sight. Here was a moving mass of earth, miles in extent, governed in part by the same laws which apply to glaciers. When Mr. Hendricks commenced hydraulicing in the ravine which has been singularly rich in gold, he met with success. As he progressed he noticed certain singular phenomena for which he could not account. In one portion of the claim the ground was found to have risen, while it had sunk at others. When piping to remove the auriferous earth, he noticed that he did not seem to progress, or to uncover the bedrock, to the extent expected, when, at last, it occurred to him that the ground was slowly moving forward, in proportion as the earth was removed by the powerful hydraulic stream. When he fully realized this, he watched more closely, and found it to be a fact. Strange as it may seem, here we have many of the conditions which produce the glacier, but the yielding mass of matter is earth instead of ice. The gravelly deposit lies on a sloping bedrock, the inclination of which is not great enough to produce a land-slide, but sufficiently so to cause the flow, so to speak, in the direction of the least resistance; and this wonderful earthy glacier (if such a term is admissible) has crawled forward for years, and, although the motion is invisible, it still continues, and will continue until it reaches a point of equilibrium. While this is a wonderful and interesting geological phenomenon, it has proved a great misfortune to Mr. Hendricks, who can see no hope of profit in washing away the surface soil, containing but little gold, which is replaced as fast as he can remove it. Here is a striking instance of the fact that common earth and rocks yield to the force of gravitation and pressure, and move for considerable distances without the assistance of water, and without being fused, as in the case of lava. This locality will become an interesting locality to the geologist, and will be more carefully studied in the future.

After carefully considering the above facts, I feel at liberty to form them into a new theory, as to the old river beds and their auriferous gravel fillings, subject to new discoveries and to the criticism of geologists. The facts cannot be disputed, while the theory is likely to be. But I trust it will lead to a fuller investigation of this most interesting and important subject, and the discovery of new facts bearing upon it.

My theory assumes that, at a period not very remote, geologically speaking, the ancient rivers flowed in similar channels to those since cut by the modern ones; that the bedrocks contained veins of gold-bearing quartz, as similar bedrocks do now in the mountain regions, above the gravels. Fragments of rocks had weathered into bowlders, which lay, as they do now, throughout the mountain region. An eruption of volcanic mud flowed from an unknown crater, followed by, and pushed forward by, an eruption of igneous lava. As the volcanic mud flowed over the land, it gathered together the bowlders lying on the surface, to which was added the rocks crushed and ground to a powder by the moving mass, by which all the irregularities of surface were filled up to a level plane, over which flowed the basaltic lava. By the erosive force of this slowly moving mass, the surface rocks were ground to a dust and the gold set free, which, with that already freed by former geological forces, was gathered together in a confused mass, as we now find it in the hydraulic and drift mines of the State. This deposit, instead of being the work of one eruption, may have been the combined labor of many, and ice may have played an important part. But if the grinding force had been wholly ice, it would be difficult to account for the universal presence of lava as a cap for all. Assuming this theory to be true, we have a grand future for gold mining in California, and we may claim that the deep placers of the State are practically inexhaustible, and that the yield of gold will not be materially diminished for many years to come.

This is the view that I take on the subject; the area adapted for placer mining is comparatively small, but the field for drift mining seems to have no practical limit. With a material modification of washing the gravels, and a judicious application of the principles of concentration, the mines may be made to yield their treasures for many years to the benefit of the country generally, as well as our own State in particular. When our miners come to consider the importance of concentration in the treatment of the placer gravels, and study judicious economy, many other minerals of value, such as platinum, diamonds, zircons, and other precious stones, now wasted by extravagant and unnecessary use of water, will be saved and will add to the profits of mining.

A resume or discussion of the theories of the ancient rivers would be out of place in this report, but that the reader may pursue the subject, if specially interesting, references are given below to important papers published:

W. P. Blake. Report of a Geological Reconnoissance in California; Pacific Railroad reports Vol. V, 1853.

Dr. J. B. Trask. Report on the Geology of the Coast Mountains and part of the Sierra Nevada; California State Document No. 9, session of 1854.

Charles S. Capp. Letters in the San Francisco Evening Bulletin.

J. D. Whitney. Geological Survey of California, 1861 to 1864.

James Hector, M. D. Quarterly Journal of the Geological Society of London; Vol. XVII, 1861.

P. Laur. Report on the Production of the Precious Metals in California to Minister of Public Works, Paris, 1862.

Titus Fey Cronise. Natural Wealth of California; San Francisco, 1858.

J. S. Hittell. Overland Monthly; Vol. I, San Francisco, 1868.

J. S. Hittell. Resources of California; San Francisco, 1879.

Joseph Le Conte. On the Old River Beds of California; American Journal of Science, third series, Vol. XIX, 1880.

J. D. Whitney. Auriferous Gravels of the Sierra Nevada of California; Cambridge, Mass., 1880.

Andrew Larsen. Mining and Scientific Press, Vol XLI; reprinted in production of gold and silver in the United States; Burchard, Washington, 1880.

C. J. Brown. Mining and Scientific Press, Vol. XXXI.

James J. McGillivray. Mining and Scientific Press, Vol. XLII.

Richthoven. Natural System of the Volcanic Rocks; Memoir California Academy of Science, San Francisco, 1868.

W. A. Goodyear. Paper read before the California Academy of Science, and published in the Evening Bulletin, San Francisco, Vol. XLVIII, No. 140.

J. C. Brown. Mineral Resources of West of the Rocky Mountains; Raymond, Washington, 1877.

Henry Degroot. Supplement to this report.

GENERAL MANIPULATION.

The experiences made in placer mining have led to the introduction of auxiliary apparatus and appliances, for the comfort of the men employed. Among these may be mentioned the electric light, and stoves for warming, during the cold nights in the mountains. These modern conveniences were preceded by more simple but more expensive and less effective substitutes. The lights were pine wood placed in a basket of iron, and the fire was a huge pile of logs, both of which required attention and could not be depended upon for steady emission of light and heat. The modern stove is made of two lengths of 22-inch water pipe, surmounted by a sheet-iron cap, reducing the size to six inches. From the top, a common stovepipe rises a few feet, to produce the necessary draught. On the side of the larger pipe near the bottom, there is a door, below which are grate bars and an ash pit. The whole arrangement is portable, and can be placed as near the pipeman as may be deemed necessary. It is a great comfort to the men during the long nights they stand at their posts.

The electric light has been introduced at the North Bloomfield mines and has given great satisfaction. The electricity is generated by a Brush machine, which is driven by a four and a half foot hurdy wheel, using six inches of water under the ordinary pressure, delivered through a three quarter inch nozzle. During the day the power is used to drive drills for making iron pipes, and a small Root blower for the blacksmith shop. By the use of the electric light the work of piping can be conducted with the same facility as by daylight. The use of this light will probably become general, not only in placer but in quartz and drift mining. The telephone is also coming into use and is found to be a great convenience. It will probably eventually take the place of the signals described in this paper. It has been found that the wires become corroded when used in tunnels and in deep shafts, but the system will no doubt be perfected and the wires protected from the influence of dampness and the gases of underground workings.

The operation of washing down the banks is called by the miners "piping," or "hydraulicing"—the c pronounced as s. The old and uncouth word "hydraulicking" is not so much used as formerly. It requires both skill and judgment to be a good pipeman. The water must be used in such a way as just to do the work required to the best advantage, without clogging the channels. The term "goosing" is used to express the driving of the debris before the stream, and "drawing," when the stream is thrown beyond and caused to flow toward the nozzle. When it is required to undermine the bank and cause the upper dirt to fall, one stream is projected against the lower part, at an angle, and another kept playing from an opposite direction, a little above the first. After a time the bank becomes undermined and falls in large bodies. This operation requires not only skill but courage, for if the men at the pipes became confused they might lose their lives. Such accidents are not common, but they do occur even with men who have had experience. No person who has not seen them in operation can have an idea of the force of these streams. If a giant nozzle should be set in front of the strongest building in San Francisco, and a stream turned on, with the usual head, the walls would melt away in a few minutes, and the building become a wreck. When the bank has fallen the streams are so managed that the debris is washed into the bedrock tunnel as fast as it can be carried away by the stream, and so the work continues night and day, until it is decided to turn the water off for a clean-up. It is considered a desideratum to keep the face of the bank square, and not to allow the depression in which the giants stand to become circular or crescent shaped.

When the gravels are very deep upon the bedrocks, it is deemed advisable to work the claim in two benches. No bank more than 150 feet deep should be worked in a single bench, as the danger of accident from accidental caving is proportionately greater. When the men at the pipes have reason to expect a cave, they should turn the water off for a few moments. If a cave should occur at the moment that the water was playing on another point, the falling bank would not slide to any great extent, but when two or more streams are kept playing at the base of the bank the dirt is partly carried on the water and rushes toward the tunnel like an avalanche, to the great personal risk of the pipemen, who sometimes are compelled to leave their stations and to run for their lives.

CHARGING QUICKSILVER.

In all hydraulic mines mercury is used in the sluices, undercurrents, etc.; the quantity and mode of charging differs with the quantity and quality of the gold. From 500 to 600 pounds are generally used in a sluice 5,000 feet long. More is required in the upper works than in the lower. It is carefully sprinkled on the surface and finds its way to the bed of the sluice, and to the riffles. After piping begins, about one flask is added per day as long as the work continues. When work begins, the water is allowed to flow for several hours before any quicksilver is added; the water is then caused to run clear and the charging commences. Each day a certain quantity of mercury is poured in until it begins to appear at the riffles. It is not considered wise to sprinkle the quicksilver into the sluices in small quantities, as when squeezed through a canvas bag, as it has been found that small globules will float on water when finely divided; yet, on this point, there is much difference of opinion. Twenty-five flasks of mercury, 1,912.5 pounds, are used in the sluices at the Gold Run Mines, Placer County, and at the Malakoff, at North Bloomfield, fifteen flasks, 1,147.5 pounds, are used in the sluices and undercurrents each run. Sometimes quicksilver is scattered over the bank to be washed, and allowed to work down with the gravel and water into the sluices.

In some mines the gravel is found so indurated, that the hydraulic stream has but little power over it; yet, it is not hard enough to require the blasting necessary in quartz mining. In such cases, the conglomerate called "cement" by the miners, is treated in a cement mill, which is so constructed as to break the connection between the bowlders, gravel, and the softer parts, and set the gold free. There are a number of styles of cement mills, each of which has its advocates; but it would be out of place to describe them here.

In other mines the gold occurs in a decomposed bedrock, which it is found profitable to work in a common battery.

CLEAN-UP.

At the termination of a run, a "clean-up" is made, which may be defined as the process of collecting the gold which has accumulated in the tunnel, sluices, undercurrents, and other gold-saving apparatus, during the run. The run may be of greater or less length, according to the ideas or the experience of the miners. Unless there are two sets of sluices, which is unusual, the clean-up should be postponed as long as possible. It may be partial or final. Some companies only clean up once a year, deferring it then until the close of the water season, but make frequent partial collections of the gold, during which the piping must temporarily cease. The time for the partial clean-up differs with circumstances; from ten days to a month being the interval most usual.

The general details of the clean-up are the same with all the miners. Each Superintendent has, however, some peculiar views relative to his mine or locality which modify the manipulation.

The clean-up at the Polar Star is made as follows: The water is not immediately turned off, but is kept playing on the bedrock until it flows clean through the sluices. It is then turned off. Three or four men commence at the head and pry up the iron rails in the tunnel with an iron bar, which has a claw on one end like a claw-hammer. The cross-rails, or ties, are then pried up and laid aside, leaving the bottom of the tunnel clear. A cleat four inches square is then laid across the lower end of the tunnel and securely fastened. Two hundred inches of water is turned on. All rails, blocks, ties, etc., are then washed by turning them in the water and scrubbing with a small broom. They are then laid aside to be used again. A man follows the water with a shovel or scoop. The lighter particles move forward, and the gold soon begins to appear. No quicksilver being used in the tunnel, the gold has its natural color. When it has been gently swept down to the cleat, the gold is shoveled into a large bucket in which thirty pounds or more of quicksilver has been placed. The sluices below the tunnel are cleaned essentially as in the case now to be described: At the Amador Mining Company's mines, near Jackson, the wooden blocks in the sluices are lifted with a pinchbar, and washed carefully with rags and sponges in water which is allowed to flow through the sluice; after which they are as carefully laid aside. There is no pavement in the bedrock tunnel, and no quicksilver is used in the tunnel, or in the first twenty-four feet of the sluice.

Before the first two lengths of blocks (forty-eight feet) are taken up, there is a strip of plank laid across the lower end to prevent quicksilver and amalgam from following the men as they take up the blocks lower down. This is continued two sections at a time, until the sluice is clear. The strips are six inches wide. They are laid across the sluice, and held in place by wedges. When the sluice is clear, the men commence at the head, just below the end of the bedrock tunnel. The sides of the sluice are washed down with a common broom, and swept clean to the first strip. The amalgam, which contains an excess of mercury, is taken up with a flat scoop, and poured into porcelain-lined kettles, such as are used by housekeepers for making preserves. The same is repeated until the whole sluice is cleaned up. In the sluice, which is 1,400 feet long, twenty-five to thirty flasks of quicksilver are used.

The upper sluices are cleaned once a month. Large nuggets do not get into the quicksilver. While the water is shut off men are sent into the washings to collect the gold which lies on the bedrock. This is called "crevicing." The men go over the whole surface, and examine the depressions, cracks, and crevices in the rock, from which they collect large quantities of gold. At the Polar Star and Southern Cross as much as three or four thousand dollars worth is sometimes gathered in a single clean-up. The instruments or tools used are iron spoons, poll picks, knives, etc. At Gold Run nuggets worth thirty dollars are sometimes found. In cleaning the sluices many curious and interesting minerals are found, with large quantities of lead bullets, shot, scrap iron, nails, spikes, etc. The principal mineral associates of gold in the sluices are zircons, platinum, chrome iron, and rolled particles of barite; occasionally, cinnabar, diamonds, magnetite, ilmenite, garnets, pyrite, quartz sand, and, rarely, stream tin.

The following is a mechanical analysis of concentrations from the Spring Valley hydraulic mines, Cherokee Flat, Butte County:

Mechanical analysis of black sand zircons and gold, clean-up of the Spring Valley Hydraulic Mine, Cherokee Flat, Butte County:

No. 1 remained on 20 mesh sieve—per cent	0.587
No. 2 remained on 40 mesh sieve—per cent	63.185
No. 3 remained on 60 mesh sieve—per cent	33.030
No. 4 remained on 80 mesh sieve—per cent	1.460
No. 5 passed 80 mesh sieve—per cent	1.738
	100.000

The magnetic portion was very small—.340 per cent. A second portion treated in Schultz's apparatus, gave the following results:

"A," first light portion—per cent	23.96400
"B," second light portion—per cent	40.99300
"C," coarse heavy portion—per cent	7.14500
"D," remained in apparatus—per cent	27.56134
"E," amalgam—*gold,* 0.10666; *mercury,* 0.23000—per cent	0.33666
	100.00000

Portion "A" was quartz in angular fragments, black sand in obscure crystals or rounded forms, small masses of globular pyrites in minute crystals, with sharp unworn angles, and small grains of quartz, with crystals of pyrite attached. But few of the black granules were magnetic.

"B," much the same, but with more black grains, some of which appear to be obsidian, a few doubly terminated quartz crystals, and clusters of pyrite crystals.

"C," nearly the same in appearance, but larger grains; all angles of pyrite unworn.

"D," this was the most interesting portion, consisting largely of perfect crystals of zircon and black grains, a few green and red in the following proportion, picked out by hand: black grains, 62; red grains, 1; zircons, 37. The black grains were heated to redness, upon which a few became magnetic. When ground in an agate mortar a brown powder was formed, which resisted the action of acids. In a bead of borax before the blowpipe a strong reaction of chromium was obtained.

"E" was gold amalgam, left in the sample, but which could easily have been removed by simple concentration. The gold was equal to $2\frac{133}{1000}$ pounds avoirdupois to the ton of 2,000 pounds, having a value of $602 92 to the ton.

Extracts from Mr. Bowie's paper:

In cleaning up sluices, the largest proportion, approximating eighty per cent. of the gold caught, is found in the first 200 feet of the head of the sluices. The gross yield of the Gardner's Point claims for the season of 1874, was $68,000 for 100 days' run. Of this amount $54,000 was obtained in the first 150 feet of the sluice, and $3,000 taken from the undercurrents. The remainder was found lower down along the sluices. The first undercurrent was 790 feet distant from the head of the sluice, and yielded fifty per cent. of the total yield of the undercurrents. The second undercurrent was seventy-eight feet distant from the first, with a drop of forty feet between them, and it contained thirty-three per cent. of the gross undercurrent yield. The third undercurrent was ninety-one feet distant from the second undercurrent, with a drop of fifty feet between them. Its yield was nearly $500.

It sometimes happens that 100 or 150 feet at the head of a sluice are covered with gravel during the greater part of a run. In such cases the gold is found so much further down the sluices. In the North Bloomfield tunnel, the upper 300 feet of the sluice is generally filled with gravel, from one to five feet deep, and still this portion yields much more amalgam per linear foot than the next 300 feet of the sluice below.

From the report of this company for the year ending October 31, 1876, the following data and facts are worthy of note, as showing the position of the gold as cleaned up in the sluices at No. 8 claim, where some 700,000 inches of water were run, washing 2,919,000 cubic yards of gravel:

	Yield of sluices.	Per cent of gross yield.
Sump	$1,510 00	.80
Flume (1,800 feet)	176,900 73	92.00
Tunnel below flume	7,290 00	3.75
Tail sluice (300 feet)	1,800 00	.95
Undercurrents	5,235 00	2.50
Totals	$192,735 73	100.00

YIELD OF GOLD AND COST OF PRODUCTION.

It is difficult, if not impossible, to obtain reliable data as to the production of gold from placer mines and cost of production. The miners of California are not ready to tell their secrets, for fear of interference. When working in small companies, before the concentration of claims and capital by the great hydraulic companies of the present day, miners were content with the daily yield and weekly division of gold taken from their placers without caring to open accounts with expenses.

It is sometimes policy for miners to overstate the yield of their mines when they desire to sell out and leave the country. Since the formation of the large companies more attention is paid to these matters. Where the requisite conditions exist, an astonishingly small amount of gold to the cubic yard will pay a profit. In many localities gravel which yields only three or four cents per cubic yard is profitably worked. Where failures have occurred they are to be attributed to a want of experience, or lack of one or more of the conditions necessary to insure success. Thirteen clean-ups were made in the North Bloomfield mines, Placer County, in the year 1876–7, at No. 8 mine; the first yield was 18.7 cents per twenty-four-hour inch of water, which increased gradually to 31.5 cents at the twelfth run. The thirteenth run yielded 44.2 cents per inch.

The whole gold bearing gravel between the South and Middle Yuba Rivers has been estimated to contain from thirty to thirty-five cents per cubic yard; the estimate is made from the actual yield of the mines of North San Juan. A hydraulic mine properly opened is considered good for $50,000 to each 100 feet linear in the channel; the flats above all pay, but not very much.

Mr. Laur, sent to California by the French Government, estimated the cost of placer mining in the State, calculating miners' wages at twenty francs per day, by the usual methods, to be as follows: By the pan, one cubic meter, 75 francs; rocker, 20 francs; long tom, 5 francs; sluice, 1.71 centimes; hydraulic, 0.28 centimes.

His estimate of the cost of moving 28,080 cubic meters was: Water, 5,000 francs; labor, 864 francs; sundries, 500 francs. Total cost, 6,364 francs.

Professor Silliman estimates that at the Blue Gravel Company's claim, near Smartsville, 17,074,758 cubic yards of water were used to wash 989,165 cubic yards of gravel.

The following two examples are given to show the enormous quantities of gravel moved to obtain a small quantity of gold:

The North Bloomfield Gold Mining Company, of Nevada County, commenced work January 1, 1875, and on the thirty-first of October, 1876, had washed 4,777,700 yards of gravel, using, in doing so, 1,086,-972 twenty-four-hour inches of water. Each inch of water moved 4.4 cubic yards of gravel, and the yield of gold to the cubic yard was 5.6 cents, or 4.98 cents to the ton. One cubic yard of gravel weighs one and one eighth tons. Therefore 5,374,912 tons of material have been washed from the opening. One twenty-four-inch of water equals 2,230 cubic feet. From this data, it has been calculated that 12,107,116 parts of gravel were moved to obtain one part of gold. One million eighty-six thousand nine hundred and seventy-two twenty-four-inches of water equals 2,423,947,560 cubic feet, which is equal to 89,724,502 cubic yards. Five hundred and seven and thirty-four hundredths cubic yards were required to move one cubic yard of gravel. The total cubic yards of water and gravel combined was 94,520,202. In 1870–4, 710,987 inches were used; yield, 13.6 cents per inch. In 1874–5, 386,972 inches were used; yield, 19.2 cents per inch. In 1875–6, 700,000 inches were used; yield, 27.5 cents per inch. In 1876–7, 595,000 inches were used; yield, 48.9 cents per inch.

At Sailor's Union mine, Iowa Hill Range, according to Professor Whitney, the excavation is 580 feet long by 160 feet wide and 116 feet deep, average; roughly, the gravel removed was equal to 398,696 cubic yards. One cubic yard has been found to weigh one and one eighth tons; nearly, or decimally expressed, 1.125 tons. Therefore, there were 448,533 tons washed. The yield of gold was, from the bedrock, $124,598; from gravel above, $42,800; total, $167,398, or 37.32 cents to the ton.

From the data given above it required the removal of 1,615,579 parts of gravel to obtain one part of gold.

LOSS OF GOLD AND QUICKSILVER.

It is well known that there is a considerable loss of gold in hydraulic mining. This has been variously estimated. It will be impossible to correctly estimate the loss until some method is devised to determine the gold in any given body of gravel, which is now beyond our power. Mr. McLean and Mr. McMurray, of North San Juan, estimate the loss of gold in large mines at ten per cent. and where there is no room for undercurrents at twenty-five per cent. The loss of quicksilver, at well managed mines, is estimated at twelve and a half to fifteen per cent. This mercury is known to carry away much gold with it.

There are three conditions in which gold escapes capture in the sluices: First, when rusty or coated. This subject will be again mentioned; second, when finely divided, or in the condition called "flour gold" by the miner; and third, when it is imbedded in other substances and passes with the debris without coming in contact with quicksilver.

I am of the opinion that vast quantities of gold go to waste as "flour gold," and that the quantity is very much greater than is generally known. All of my experiments and study of the auriferous sands of our sea coast tend to confirm this opinion. The following is an extract from Mr. Bowie's paper, which gives some very interesting facts bearing on the loss of quicksilver and gold:

In hydraulic mining a loss of quicksilver cannot be avoided, the amount lost depending on the character of the gravel washed, the quantity of water used, the grade, length, and condition of the sluices, and on the number of days run. The use of a long line of sluices, kept in good order, and the employment of undercurrents, tend to diminish it.

The aggregate amount of quicksilver lost at the La Grange hydraulic company's mines, during a period of two and one half years, in running six claims—1,520 days (twenty-four hours), washing and moving 2,275,967 cubic yards of gravel, and using 1,533,728 inches of water (2,159 cubic feet each)—amounted to 553.75 pounds quicksilver. The North Bloomfield claims for the year ending November 3, 1875, used 464,600 miner's inches of water, and 9,649 pounds of quicksilver were employed in the sluices. The loss of quicksilver at the respective claims was as follows:

Name of Claim.	Miner's inch used.	Length of sluice. Feet.	Loss of Quicksilver—Lbs.	Per cent.
No. 8	386,972	1,800	900	11
Woodward	51,550	600	217	25
Eisenbeck	26,000	400	125	25

The losses at the Woodward and Eisenbeck claims are attributed to old and poor sluices and steep grade. For the year ending October 31, 1876, the loss of quicksilver at the above mentioned claims was as follows:

Name of Claim.	Miner's inch used.	Length of sluice. Feet.	Loss of Quicksilver—Lbs.	Per cent.
No. 8	700,000	1,800	2,251	----------
Woodward	30,000	600	123	----------
Eisenbeck	56,200	400	182	----------

After a careful study of this most interesting and important subject, I cannot evade the conclusion that hydraulic mining, notwithstanding its wonderful advancement, is still in an imperfect state. I am convinced that more gold is lost than is generally known, or miners are willing to admit. This being granted, a remedy should be sought, and as theory is not always confirmed by practice, experiments on a moderate scale should be made, based on the experience of miners, who are aware of the loss but helpless to prevent it.

It is my opinion that the methods now employed in hydraulic mining should be materially modified. As far as the disintegration of the gravels is concerned, nothing could be better, but the very force used in this operation defeats the object if carried too far. I consider it a foregone conclusion that coated gold cannot be saved by the use of quicksilver alone, and that it, with much of the fine gold, is carried forward by the great force of the water in the sluices and lost in the dump. This force, necessary to wash down the gravel banks, is not desirable in the sluices; on the contrary, it is highly detrimental, if the great mass of the worthless material can be got rid of at an early stage of the operation, as practiced on a small scale in pan washing. It is only to carry this debris through the sluices that this powerful current of water is required.

It is easy to find fault with the working of any process in use, but not so easy to propose a remedy. What I am about to suggest is purely theoretical, and may not work in practice, but it is worthy of the consideration of miners. The "grizzly," already described, now used in nearly all hydraulic mines of the State, to sift out—on a large scale—the bowlders present in the flowing debris, and it is a recognized principle to do this as early as possible. The debris freed from the larger bowlders passes through the sluices more freely, after which it is caused to flow over the pavements and dropped on the bedrock. But there is a point beyond which this treatment should cease. The proper point being decided upon, a set of grizzlies should be introduced, diminishing in fineness until the last one is no wider between the bars than twice or thrice the width of the largest particles of gold found in the mine, as learned by experience. What remains on the grizzlies should be conveyed to the dump by a special channel, using a large portion of the available water for that purpose, or, when possible, shot off into some lateral cañon or depression. To divide the water, and, at the same time, to allow a portion to pass through with the fine gravel and sands, the bars of the last grizzly should be laid at right angles with the current and given the proper grade, which can only be learned by experience. What passes the last grizzly should be conveyed—using the remainder of the water—through sluices, as at present, but with less grade, and so constructed that a considerable portion of the heavier matters should remain in them, including the gold, arrested by properly constructed riffles. From this point it might be necessary to have double sluices, one to be used while the other is being cleaned up.

At proper periods, as determined by experience, the accumulation should be removed and concentrated, using either of the well known concentrators for that purpose. Rusty gold would thus be saved by its specific gravity, which is known to escape the quicksilver, while fine gold, moving more slowly in the less inclined sluice beds, would find its way to the bottom and be saved. This is attempted now in the undercurrents, but the fault with them is, that there is too little space provided for the accumulation of the heavier parts of the material washed, and the absence of the secondary concentration. Small bowlders are now rushed through the whole length of the sluices and dumped into the rivers, miles away. It is absurd to suppose that gold should not be carried forward with this rush of water, and especially so after the interstices between the pavement blocks are filled.

At the American mine, Nevada County, there are twenty undercurrents, and gold is saved on the last one. Is it supposable that another would not also save a portion of the precious metal? It is a well known fact that diamonds exist in the gravels of some of the deep placers, and it may be assumed that they are also in others not now known, yet it seldom occurs that one is found, which I consider another proof that too great a force of water is employed in the sluices below the bedrock tunnels.

This proposed improvement is clearly based on the results of my experiments, and it seems to be theoretically correct, but how it will meet the views of the experienced miners, or how it will work in practice, remains to be proved.

DRIFT MINING.

Drift mining is resorted to in cases where it is impossible to extract the gold by any of the methods mentioned above. The subject has been fully treated by Dr. Degroot, in his paper published in this report as a supplement, and to which the reader is referred.

CLEANING AND RETORTING THE AMALGAM.

The amalgam is carried from the sluices to a room in which there is a strong table made of heavy sugar-pine planks. The table is slightly inclined, and at the lower end there are grooves and a hole bored at the lowest point, under which is placed a large vessel to save any quicksilver that may escape in the operation of cleaning. On the table is placed a large iron kettle, capacious enough to hold all the quicksilver collected in a single clean-up. Into the collected amalgam and quicksilver, sodium amalgam—one ounce to each flask of quicksilver—is introduced, and the whole stirred. This is considered of great advantage, and at the Amador mines is never neglected. After some time, water is poured into the kettle, above the quicksilver, and the whole again stirred. Considerable sand and mud rises to the surface, which is removed, using a large common sponge for that purpose. This successive washing and stirring is continued until the surface is comparatively clean. The mercury is then made as dry as possible with the sponge, and the whole again stirred with the hands. Some dirt generally rises, which is scraped off with a dry card or piece of leather held edgewise and drawn gently over the surface. This is repeated, with occasional stirring, until the quicksilver seems to be free from mechanical impurity. It is then poured into conical bags of canvas, through the pores of which the mercury runs, leaving the gold amalgam in the bag. A certain quantity of gold is retained by the mercury, which can only be recovered by retorting.

Placer gold in quicksilver does not make a homogeneous amalgam. The retorted gold, if it is not allowed to melt, looks like gold panned out of the claim. My experiments go to show that it is nearly impossible to wholly dissolve placer gold in mercury to a homogeneous amalgam, like that obtained from the quartz mill. In retorting ten flasks of strained quicksilver used in the sluices, Mr. Bluxome, of the Amador mines, obtained $223 worth of gold. Mr. Bluxome thinks planing the inner surfaces of the planks used in the construction of the sluices is of great advantage. It greatly facilitates the clean-up.

Sodium amalgam used in the clean-up should be freshly made to be effective. If long kept it becomes oxidized and does not give satisfactory results, and the coal oil poured in the bottle by the manufacturing chemist is detrimental to the collection of the gold. For these reasons it is sometimes unjustly condemned. It should be prepared by the miner himself, in quantities to suit, and immediately used. The preparation is simple and requires no skill. Metallic sodium may be kept in a convenient wide mouth bottle, covered with naphtha or coal oil. It is best to keep it in large pieces, and to cut it into small cubes when required. All that will be required for a single clean-up can be made in a small frying pan. The details of the operation are as follows:

The pan must be perfectly clean and dry. A small quantity of mercury from a fresh flask, or at least not contaminated with mineral impurities, say five or six pounds, is poured into the pan, and dried, first with a sponge, and then by heating hotter than boiling water, but not so much so as to volatilize any of the mercury, which would be dangerous to the health of the operator. In the meantime, a piece of sodium is taken from the bottle and wiped with a perfectly dry rag. It is then cut into half-inch cubes. This is done with a common knife, the metal cutting like wax. The mercury is taken out into the open air. The operator places himself on the windward side of the pan, and lifting one of the small cubes of sodium with a long pair of cupel tongs, or pointed wire, places it in the center of the warm mercury. A flash will follow, and a small quantity of the mercury will be volatilized. Another cube is laid in the same place, and the same flash will follow, but it will be less intense. This is repeated three or four times, when the sodium will sink down quietly. At the proper moment it will be observed that there is a solid mass of amalgam in the center. It will then be perfectly safe to stir the contents of the pan, when a few more cubes added will change the whole to a mass of beautifully crystallized sodium amalgam, which may be put into closely stoppered glass bottles, in which it will keep for some time without coal oil or other protection, but when the bottle is opened the whole should be used, as it will soon, otherwise, decompose and spoil. The bottles in which it is kept should be selected to hold just what is required for use at one time.

It will be found every way advantageous to the miner to make his sodium amalgam according to these directions. The precautions to be observed are to avoid the fumes of mercury during the operation, and to be sure that everything used is perfectly dry. After the sodium amalgam is made it can be used with perfect safety.

As taken from the battery of a quartz mill and copper plates, gold amalgam is mixed with sand, metallic iron, bits of quartz, and other mechanical impurities. It is generally gathered in miners' pans or wooden buckets; when the clean-up is large, the amalgam is collected in a number of vessels, which contain, also, a large quantity of water. This is removed by the use of a large sponge, and the whole amalgam transferred to a single capacious receptacle. From this, any visible lumps of quartz, or other foreign matter, are carefully removed by hand, and a considerable portion of clean quicksilver poured in; the whole being thoroughly mixed. In this condition, all foreign substances float upon the surface, like bits of wood on water. When the coarse fragments of iron or quartz are removed, and the quicksilver seems homogeneous, the sponge is again used, to remove all the water. A piece of soft unglazed paper is then plunged through the mercury, which absorbs any remaining moisture, leaving the mercury dry. A small piece of blanket or flannel, five or six inches square, or a card, is then held by two corners, and drawn toward the operator, while it is lying flat on the surface of the quicksilver. If a card is used, it is held nearly vertical. This will clear it of the iron, which, by a dexterous turn of the cloth, may be rejected. The hands are then plunged in, and, by agitation, more iron and sand comes to the surface, which is taken off as before. This operation is repeated until the mercury is perfectly liquid and clean, and until no more impurity rises to the surface when freshly agitated.

The quicksilver is then poured into a linen bag of the proper texture, which retains most of the amalgam. It is not usually thought best to remove the last traces of gold from the quicksilver, except in a general clean-up, or after some special run, where it is required to determine the full yield of a certain working, for it is found that mercury containing some gold (when there is no base metal contained in it) works better than when freshly retorted, and consequently pure.

When the amalgam has drained sufficiently it may be removed from the bag. To make the cleaning perfect, the amalgam is squeezed in a piece of chamois leather, or cotton rag, and the hard ball placed in a clean iron miner's pan and broken down with the thumb. By this treatment it becomes soft, and any fragments of iron or quartz left accidentally in the amalgam become disengaged and may be removed. The whole of the amalgam is again squeezed and the process of "breaking down" with the thumb repeated until it becomes homogeneous and hard. It is then ready for the retort.

For small operations the retort used is a deep cast-iron vessel, shaped somewhat like a bowl. The top edge is planed level, and upon this fits a cover, also planed true, so that when put together, the two parts form a perfect joint. From the cover an iron tube rises and bends downward, at an angle of about twenty degrees, from the horizontal. The cover is fastened by a clamp and set screw. A mixture of wood ashes and clay is prepared by mixing them into a thick paste with water. When all is ready the balls of amalgam are placed in the bowl, the mixture of ashes is put thickly around the edge, the cover fitted, clamp adjusted, and the whole firmly fixed by means of the set screw. All the superfluous luting is removed, and the retort placed in a furnace over a moderate fire. The end of the pipe must dip just below the surface of water placed in any convenient vessel; if the fire is kept well under control there will be no necessity of cooling the pipe. It sometimes happens that when the amalgam has been imperfectly cleaned, the gold will stick to the retort; this may be obviated by chalking the interior of the retort, or putting a piece of common writing paper under the amalgam balls. However, when the amalgam is clean and has been thoroughly worked over, as above described, the gold will come out easily.

A very convenient way to retort is to drive two small stakes into the ground, and to fasten a small iron rod to each, at a convenient height; upon this the retort is hung, and around it a fire of small wood built. When the retort has attained a dull red heat, and no more mercury distils over, the fire is put out and the retort allowed to cool; the cover is taken off and the bullion removed. If the amalgam has been properly cleaned, it will be found after retorting, to be metallic in appearance, and of a gold color. It is ready for the melting pot as soon as taken out.

It is never safe to open the retort before it is cool, nor will it stand being cooled in water. Many persons have done themselves great injury in their impatience to see the result of an important run, by opening the hot retort and inhaling the poisonous mercurial fumes.

In extensive runs, when the clean-up is large, a retort of cast iron, made something like a gas-house retort, with movable front door, is set in brick work and furnished with a cooler surrounded by constantly changing water.

When it is required to retort quicksilver, the retort is used in the same way as with amalgam, with this exception: a handful of shingle nails are placed on the surface of the mercury, which prevents violent ebullition of the metal.

There should be a small room expressly for the amalgamator, where the amalgam may be taken for treatment. It should be furnished with a strong wooden trough filled with water. Just above the water a shelf should be placed, upon which to set the pan while cleaning the amalgam. Any quicksilver accidentally spilled while washing may be removed at any time by drawing off the water. The trough should be furnished with a hydrant, which should give an abundant supply of water.

Inexperienced miners find it difficult to separate amalgam from iron, and it is too often put into the retort without proper cleaning, in which case the bullion comes from the retort looking like soot; yet the management of amalgam is simple, and when once understood there need be no failure.

Many experiments have been made to clean improperly retorted gold bullion by the use of acids. This is nearly always attended with loss of gold or is inoperative. I once saw a miner in Mariposa County cleaning crude bullion just from the retort, by boiling in aqua regia—nitro-muriatic acid—after which he threw the acid away.

Some miners wash the amalgam as taken from the bags, first in diluted sulphuric acid, and then with nitric acid supposed to be pure. It is almost needless to say that such treatment shows gross ignorance. It is better to properly clean the amalgam and to flux off any accidental impurity, in the crucible.

ASSAY OF GOLD BULLION.

To make absolutely accurate assays of gold bullion requires care, skill, and first-class apparatus. The skill may soon be acquired by practice, but the apparatus must not only be of the very best quality but must be kept in the most perfect state of adjustment. It is not enough to purchase chemicals which are marked "pure," or a balance, supposed to be accurate. The chemicals must be tested and the accuracy and adjustment of the balance and weights verified before correct results can be certain.

The process of assaying gold bullion is divided into several operations as follows: Melting the crude gold and casting the bar, cutting the assay chips, the assay proper, calculating the results, and stamping the fineness and value on the bar.

For melting, a wind furnace is best, but a good coal stove, such as used in offices, will answer the purpose if the amount operated upon be small. The wind furnace is a square box of firebrick, built in the form of a cube of three-foot face, with an opening in the center of the upper face. The firebox is about a foot square and fourteen inches deep, provided with an ash pit, movable grate, bars, and sliding cast iron cover. The flue should be a horizontal opening, about three by six inches, near the top of the firebox, and connected with a chimney at least thirty feet high, to insure a good draft. The furnace can be built by any bricklayer of ordinary skill and judgment. No mortar should be used in laying the firebrick, but good clay, mixed with a portion of coarse sand substituted.

Gold is generally melted in a black lead crucible. Before such a crucible can be safely used, it must be annealed. Were this neglected, and it should be placed in the fire without this precaution, it would soon fly to pieces. This is caused by the water it contains being converted into steam; the structure of the material being such that it cannot make its escape, destruction of the crucible follows. It is best to commence annealing the crucible sometime before it is wanted. It should be set near the hot furnace for several days and turned occasionally. When the fire is nearly spent, it may be placed, rim downward, upon the hot sand in the pan generally placed on top of the furnace. A day or two of such treatment will make it safe to hold it over the open furnace by the aid of the crucible tongs or poker. After it has been frequently turned, and is hotter than boiling water, it is safe to place it, rim downward, upon the burning coals. When the rim is redhot, all danger is passed, and it may be turned and placed in position for the reception of the gold.

If the fuel is charcoal, it will be best not to use small pieces, or at least not coal dust. Pieces the size of an egg, or larger, will make the best fire. When the crucible becomes redhot, a long piece of quarter-inch gas pipe is used to blow out any dust or ashes that may have fallen into it. A cover is then placed on the crucible, and lumps of coal built up around it with a long pair of cupel tongs.

When the crucible has attained a full red heat, one or two spoonfuls of borax, wrapped in paper, are placed in it, using the cupel tongs. When the borax has melted, a small quantity of gold dust, also wrapped in paper, is placed in the crucible in the same manner. Several portions may be thus added, according to the size of the crucible. A fresh supply of charcoal must be built up around the crucible when required, the cover having been previously replaced. When the gold has melted down, more is added in the same manner, until the crucible has received all that is to constitute the bar. In the meantime, the ingot mold, in which it is intended to cast the gold, must be made smooth and clean inside. This is best done by rubbing with sandpaper and oil, or with a dry piece of pumice stone. It is then wiped dry and clean with a rag, oiled slightly, and placed on the edge of the furnace in such a position that it may become quite hot; not so hot, however, as to approach redness, nor to cause the oil to burn.

When the gold is in a fluid state in the crucible, the mold must be placed on a level surface and oil poured into it. To make a clean bar it will be found best to use considerable oil—sufficient to cover the bottom of the mold to the depth of at least one fourth of an inch. The mold should be turned in such a manner as to allow the oil to flow to all parts of its interior, and then placed again level and in the position it is to occupy while casting the gold. If the gold is clean, and the quantity less than fifty ounces, it is best not to attempt to skim it. Two spoonfuls of nitrate of potash may be added, and one of carbonate of soda, and the whole allowed to melt and flow over the surface of the gold. When very hot and the slag perfectly fluid, the crucible is lifted from the furnace and with a bold and steady hand poured into the mold, holding the crucible for a little time in an inverted position to allow the last portion to flow from the crucible. The oil inflames and remains burning on the slag, which flows evenly on the surface of the gold. If the mold is clean, and of the right temperature, and if sufficient oil is used, a clean bar will result. A little practice will enable the operator to hit the exact conditions. The oil used should be a cheap animal oil; common whale oil answers every purpose; lard oil is also well suited. Coal oil is too inflammable as well as dangerous, and should never be used. When cold the bar falls easily from the mold; a slight tap with a hammer separates the slag, and the bar may be cleaned with water and nitric acid, or, if necessary, with sand and a suitable brush. A good plan is to place the bar in the furnace until it becomes nearly red hot, and then to quench it suddenly in water. This will be unnecessary if proper precautions have been observed in preparing the mold.

When the gold is very impure—which is the case when in the form of retorted amalgam which has not been properly cleaned—a different method of treatment should be adopted. A larger sized crucible will be required. Three or four times the amount of flux must be put in, with the addition of a spoonful of carbonate of potash. A skimmer must be prepared by forming the end of a large wire, about the size of a common lead pencil, into a spiral about an inch and a half in diameter, and bending it so that when the skimmer is let down vertically into the crucible, the spiral will lie flat upon the surface of its contents. A bucket of water is set near the furnace, and, when the slag has become fluid, and it is beyond question that the gold has become perfectly melted, the skimmer is touched to the slag and gently moved from side to side; a portion of the slag adheres to the iron, the skimmer is removed and plunged into the water, and immediately replaced in the crucible; an additional portion attaches itself to the skimmer, which is again quenched in water. This is repeated until a large portion of the slag is removed, and a new charge of flux, consisting, this time, of borax and nitrate of potash, is allowed to fuse upon the surface of the gold. The first flux is removed from the skimmer by a slight blow with a hammer, and the crucible is skimmed with it as before. This must be repeated until all iron and other impurities have been removed, and the surface of the molten gold appears, when exposed, clean and reflective as a mirror. It may then be poured into the mold, as described before. Care should be taken not to dip the wet skimmer beneath the surface of the gold, or an explosion will take place.

In large meltings it is customary always to skim the gold before pouring, and so far to remove the slag that any remaining portion may be left on the sides of the crucible, and the gold only allowed to flow into the mold. This requires some skill and considerable practice. As it is imperative that the bar should be homogenous to insure a correct assay, it is usual to mix the melted gold thoroughly before pouring. This is done in the large way by stirring just before lifting from the furnace. It may be done with an iron rod, with a piece of black lead held with the tongs, or with a clay stirrer made specially for that purpose, in which case it will be necessary to allow it to remain in the crucible until it has acquired the temperature of the fused gold; otherwise, a portion of the gold may attach itself to the stirrer and be removed with it. In small meltings it will be found sufficient to mix the gold by giving the crucible a rotary motion while holding it with the tongs just previous to pouring. This must be done so quickly that the crucible has no time to cool. For very small fusions it is best to use a small Hessian crucible, and, when the gold is melted with plenty of flux, to set it aside to cool, and then break the crucible and separate the pieces of crucible and portions of slag by slight blows of a hammer on the edges of the button. It is very difficult to pour small quantities of gold without loss, from portions remaining on the sides of the crucible.

When the bar is clean, a small portion must be taken from different parts for assay. It is customary to cut from opposite corners with a cold-chisel, but this is extremely clumsy and in every way inconvenient. If the bar is brittle, a much larger piece may break off with the chip than is required. If the proper sized chip is cut off successfully, it is likely to fly away and be lost. A better way is to bore into the bar in different parts, with a small drill. This may be done in a lathe, or by means of a ratchet drill. The bar should be placed in a clean copper pan so that no loss may occur; the surface borings, resulting from the first revolutions of the drill, should be rejected. Those that follow, to the extent of a little more than one gram, are to be placed in a suitable vessel and carefully preserved for assay. Before cutting or boring the bar, the number of the assay should be stamped upon it, and the same number placed with the clippings. This number should represent the bar through every stage of the assay by which its value is ascertained. Some assayers stamp the initial of their name on the cut faces, so that no portion can be removed after it leaves their hands.

The next step is to ascertain the weight of the bar in troy ounces and decimals. This must be done with the greatest accuracy. A good bullion balance is much to be desired; but a bar can be weighed on a defective balance if it is sufficiently delicate to turn distinctly with the hundredth part of a troy ounce. This method of weighing is called counterpoising, and is conducted as follows:

The beam must first be brought to a level by putting sand, small shot, or other convenient weights into the lightest pan. When in perfect equilibrium, a small weight is placed in one of the pans to test the delicacy of the movement, and if satisfactory the bar is laid in one pan and the equilibrium restored by putting any convenient substance, as sand, into the other. The bar is then removed and ounce weights put in its place, which will be the exact weight of the bar, all errors of the apparatus being corrected by counter poising, which will be evident to the reader without further explanation. Of course the ounce weights must be proved by experiment to be correct among themselves.

It is sometimes impossible to obtain troy ounce weights, in which case avoirdupois may be used. The same rule as to accuracy applies equally to them. Each pound equals 14.5833 troy ounces. An excess of even pounds must be made with ounces and decimals, which can be prepared by any person of moderate mechanical skill. The value of an avoirdupois ounce is 0.911458 ounces troy, or one-sixteenth of a pound. To make the calculation it is only necessary to multiply pounds by the former and ounces by the latter factor and add the two together. The following table may be used to facilitate the calculation:

Avoirdupois.	Troy ounces.
1 ounce	0.911458
2 ounces	1.822916
3 ounces	2.734374
4 ounces	3.645833
5 ounces	4.557291
6 ounces	5.468749
7 ounces	6.380208
8 ounces	7.291666
9 ounces	8.203124

Avoirdupois.	Troy ounces.
10 ounces	9.114583
11 ounces	10.026041
12 ounces	10.937499
13 ounces	11.848958
14 ounces	12.760416
15 ounces	13.671874
1 pound	14.583333
2 pounds	29.166666
3 pounds	43.749999
4 pounds	58.333333
5 pounds	72,916666
6 pounds	87.499999
7 pounds	102.083333
8 pounds	116.666666
9 pounds	131.249999

Suppose the bar to weigh twelve pounds and nine ounces, set the figures down thus:

10. pounds.
2. pounds.
.9 ounces.

12.9

Look for ten pounds in the table, which will be the same as one pound with the decimal point moved one place to the right; 145,833, opposite two, will be found 29,166; nine ounces will be found to be 8,203, which are to be added as follows:

10. pounds	145,833
2. pounds	29,166
0.9 ounces	8,203
12.9—weight of the bar.	183,202 troy ounces.

When decimals of an ounce are calculated, the values may be taken from the first column of the table. Suppose the decimal to be .7, or 7-10, move the decimal point in the seventh line one place to the left, and the result will be .6380208, which is to be added to the sum of pounds and ounces.

The above method of weighing is sometimes convenient in isolated mining localities where no accurate bullion balance or large sets of troy weights can be obtained.

A table having been given to calculate troy ounces from avoirdupois pounds, the following table has been calculated to reverse the operation, and it will in many cases be found convenient:

Table for Changing Troy Ounces to Pounds and Decimals Avoirdupois.

Troy ounces.	Pounds—avoirdupois.
1	.06857
2	.13714
3	.20571
4	.27428
5	.34285
6	.41142
7	.47999
8	.54856
9	.61713

Gold is always calculated in troy ounces and decimals. A convenient set of weights may be constructed as follows:

Ounces.	Decimals.
500	0.500
300	.300
200	.200
100	.100
50	.050
20	.020
10	.010
10	.010
5	.005
2	.002
2	.002
1	.001

The weight of the bar being accurately ascertained, the next step will be "the bullion assay proper."

The method of conducting the assay is as follows: The assayer seats himself before the balance, having the clippings in a convenient position inside the case. Half a gramme weight is placed in the right-hand pan of the balance and portions of the clippings in the other until nearly correct, but the gold should be in excess. The largest piece is then removed by the aid of a pair of pliers, and touched against a clean file, by which a minute portion is removed. By careful manipulation nearly the exact point will soon be obtained, but with the greatest care; if the balance is delicate, it will be found nearly impossible to adjust the weight so perfectly that the index will not point either one side or the other of the zero. In such a case, it will be necessary to make a memorandum of the error and mark it with the number of the assay, and in weighing the cornet to take the same reading of the index.

The gold is removed from the balance-pan and carefully folded in a piece of leadfoil an inch square. Care must be taken in preparing this lead, that it is as pure as possible. It must contain no trace of gold. Its purity being established, it is easily prepared by rolling out to a uniform thickness and cutting into inch squares; these should always be prepared by the assayer himself, and kept on hand in sufficient quantity. Two assays must be prepared, as described above. Two small, well made cupels are then to be placed in the muffle, and when hot, a piece of pure lead, weighing three grammes, is placed in each, which will soon melt and begin to "drive"—that is, begin to be absorbed by the cupel—the assays are then to be added, using the cupel tongs. When perfectly melted, the cupels are drawn forward to that point in the muffle which experience has shown to the assayer that cupellation progresses most successfully. When the cupellation is finished, and the buttons have assumed a brilliant yellow metallic luster, they are removed, hammered slightly on their edge on a clean anvil, and examined carefully with a magnifying glass to see that all bone ash has been removed. The two buttons should weigh exactly alike; if this should not be the case, the heaviest one must be examined carefully to see if any particle of bone ash may have been overlooked. If this should fail, there is no recourse but to make another assay, which should agree with one of the first. The correct weight of one of the buttons in half milligrammes represents the total fineness, or the gold and silver in the bar, expressed in thousandths.

The weight of the buttons being carefully noted, pure silver is added and they are again cupelled. It has been found that silver cannot be dissolved out of an alloy of that metal with gold, unless the proportion of silver is at least two and one half times that of the gold. If a larger proportion is used, the gold is left in the form of a powder, and cannot be dried and weighed without danger of mechanical loss. If less, the gold protects the silver, and the action of the acid ceases, while some of the silver remains undissolved. An alloy of three parts of silver to one of gold was formerly taken, from which the common term quartation comes, but of late years the above proportions have been found to be best.

As the button resulting from the first cupellation may contain silver, it will be necessary to ascertain if such is the fact, and if so, in what quantity it may be present.

A preliminary assay is easily made by means of touch needles, to be described. When great accuracy is required—as in case of many assays of gold from the same mine—half a gramme may be cupelled with five or six parts of silver and the proper quantity of lead, the resulting button rolled out and boiled in nitric acid, as will be fully described hereafter. With the data so obtained it will be easy to make up the proper alloy for the actual assay. By this method the gold will be obtained as a powder, but the results will be sufficiently accurate for a preliminary assay. For all practical purposes the test needles will give results sufficiently exact, and may be confidently used after a little practice.

Two sets of needles will be required, one, the alloy of which is silver, the other copper. These needles can be made by any handy person. Absolutely pure gold and silver are required.

The ordinary plan is to draw out copper wire through a wire plate with square holes, to about the size of the square point of a tenpenny nail. This is cut into lengths of about two inches—five of these constitute a set. It is best to commence each with pure gold; but only one is actually necessary, for pure gold is, of course, the standard of either set.

Weigh out ten grains of pure gold, melt before the blowpipe in a cavity in a piece of charcoal, hammer square and solder to the end of one of the square wires. This requires some skill and an understanding of the nature of this kind of soldering, but any jeweler can do it from this description. When soldered, file down even with the sides of the wire, and stamp on the wire 1000, which represents pure gold. For the other end make an alloy by weighing out very carefully nine grains of pure gold and one grain of pure silver; these are melted on charcoal, together—care being taken that sufficient heat is produced to render the alloy perfectly fluid—hammered square and soldered in the other end of the first needle. This is stamped 900. One needle being complete, the others are made in the same way, as follows:

Grains gold.	Grains silver.	Stamped.
8	2	800
7	3	700
6	4	600
5	5	500
4	6	400
3	7	300
2	8	200
1	9	100

The second set is made in exactly the same way, except that copper takes the place of silver in the alloy.

The only source of error is the heating of the solder so hot that it melts the alloy, and by fusing with it a new and unknown alloy is formed. The alloy should be considerably larger than the needle so that it can be filed down, thus removing the solder from all parts except where the copper is joined to it.

A touchstone is best purchased, but the black quartz stones found in the beds of some rivers and creeks will answer the purpose if they will scratch glass, and acids have no effect upon them. A smooth face should be formed by grinding. The true touchstone is a variety of black quartz called basanite or Lydian stone, from a well known locality. It is also found in Bohemia, Saxony, and Silesia.

The touch needles are used for comparison, as follows: The alloy to be tested is rubbed on the touchstone, leaving a characteristic metallic streak; the needles are then compared with the streak on the stone by placing them in succession beside it, until one is found which appears the same in color to the eye; a comparative streak is then made with this needle, parallel and near the alloy, both of which are then closely observed under a common lens; if they exactly compare, the alloy is supposed to be the same degree of fineness as the needle; if not, a similar experiment is made with needles finer or otherwise, as the case may be; a glass rod dipped in strong nitric acid is then touched to the stone covering a portion of both streaks; the action of the acid gives confirmatory evidence as to the fineness of the alloy.

An example will fully explain the manner of making up the alloy when the fineness is made known by actual experiment.

The button is found to weigh 972 one-thousandths of the unit, according to the weights used, and by preliminary assay, the gold 896 fine; which is 896 thousandths. It is evident that there is 896 of gold and 76 of silver in the alloy, very nearly. If these results were accurate, there would be no use of proceeding any further, but the results are only sufficiently so to insure a good alloy for the continuation of the assay. Multiply the gold by 2.5, which will give the silver required to be added to the gold, $.896 \times 2.5 = 2{,}240$; but there is already .076 parts of silver with the gold, which must be subtracted, therefore 2,164 is the amount of silver to be added to the button: $.896 \times 2.5 - 76 = 2{,}164$.

In cases the touch needles are used, a different calculation will be necessary. The following formula is self explanatory:

Let "A" equal the weight of the button after cupellation in millegrams.
" B"=The fineness of the gold in A, as determined by the touch needles.
" C"=The gold in the button approximatively.*
" D"—The silver required for parting (two and a half or three parts).
" E"=The silver already in the button.†
" F"=The weight of the silver to be added to the button for parting.

The silver used need not necessarily be chemically pure, but it must contain no trace of gold. It is convenient to roll it out in thin strips to be cut with scissors as required.

When the proper amount of silver is weighed out it is to be folded in lead foil, with the gold button, and cupelled as before.

Two of the gold buttons which weighed alike in the first cupella-

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* $A \times B = C$ } Then $C \times D - E = F$.
† $A - C = E$ }

tion, must be alloyed with silver and treated as above. It is not absolutely necessary to cupel the alloy the second time, but it is convenient to do so while the muffle is hot—it insures a malleable button, which can be rolled out without breaking, and there is more certainty, in unskillful hands, of perfect fusion, and, consequently, perfect mixture of the two metals, which must be the case to obtain perfect results. But the gold and silver may be melted together in a cavity in a piece of charcoal, by a person skilled in the use of the blowpipe, with the same certainty of success as when the muffle is employed.

The buttons resulting from the second cupellation are removed from the cupel, hammered slightly on the edges, to remove bone ash, and afterwards flattened on an anvil by blows from a small hammer, the last blow being given near one edge, to make that part thinner, in order to facilitate the rolling process which follows.

At this stage, before rolling out the alloy, the buttons should be annealed; which can be done in the muffle, if still hot, or upon charcoal, with the flame of a spirit lamp urged with a blowpipe. They are then rolled out into ribbons about three inches long, and rolled up into a spiral form upon a glass rod or lead pencil. A slight pinch, after the rod is removed, will prevent their unrolling. They are then ready for treatment with acid.

The *cornets* are next placed in clean flasks and covered with about a fluid ounce of twenty degree nitric acid, placed on the sand bath which acts as cover of the furnace, as before mentioned, or on a small sand bath supported on the ring of a retort stand over a spirit lamp, and boiled until no more red flames are evolved. A folded piece of paper, or a pair of wooden tongs, are used to lift the flasks and pour the acid carefully into some convenient vessel kept to receive it, as the silver is valuable, and may be recovered when a sufficient quantity has accumulated. The same quantity of thirty degree acid is then poured into each flask, and, being placed on the sand bath, again boiled. A small piece of charcoal, which must not contain chlorine, is put into each flask to prevent bumping. After five minutes' boiling, the acid is poured off, and each flask is filled up with distilled water, which is carefully rejected, and the flasks again filled with the distilled water, this time quite to the brim. Over the mouth of each flask a dry cup is placed, mouth downward, like a cap, and the flask and dry cup inverted together. The cornet falls gently and without breaking to the bottom of the cup. The flask is then gently raised until on a level with the edge of the cup, when, with a quick side motion, the flask is removed and held for a moment to allow the water to fall from it, when it is set aside. Both flasks are treated in the same way. The water in the dry cups is then poured off without disturbing the cornets, after which each cup with cornet is heated redhot in the muffle. The gold will be found to have regained its natural color, and can be removed without danger and taken to the scales to be weighed. If the operation has been skillfully conducted, the result is practically pure gold. It must be weighed accurately, noting any memorandum regarding the position of the index in weighing out the bullion in the first operation. Its weight in half milligrammes will represent the fineness of gold in the bar, expressed, as before, in thousandths.

Suppose the total fineness to be 970, and the fineness of gold as found by assay, to be 898, by subtracting the result from the first, the fineness of silver will be found to be 072. Now, as one ounce of pure gold is worth $20.6918, one one thousandth will be worth $0.0206718, therefore, an ounce of alloy, containing 898 parts of pure gold, would be worth 898×0.0206718, or $18.56327. The last three decimals may be disregarded unless the bar is very large.

The value of the silver is obtained in the same way. An ounce of pure silver is worth $1.2929, and one one thousandth equals $0.0012929. This, multiplied by the fineness of silver as found, would give the value of the silver in each ounce of the bar.

To facilitate this calculation I have computed a table by which multiplication is avoided:

Table for determining the Value of Gold and Silver Bullion.

FINENESS.	Gold.	FINENESS.	Silver.
.000½	.010335917312	.000½	.000646464646
.001	.020671834625	.001	.001292929292
.002	.041343669250	.002	.002585858584
.003	.062015503875	.003	.003878787876
.004	.082687338500	.004	.005171717168
.005	.103359173125	.005	.006464646460
.006	.124031007750	.006	.007757575752
.007	.144702842375	.007	.009050505044
.008	.165374677000	.008	.010343434336
.009	.186046511625	.009	.011636363628

The manner of using this table is the same as a similar one before described:

800 same as 008 decimal 2 places right	= $16.53746
090 same as 009 decimal 1 place right	= 1.86046
008	= .16537
898 Value of gold per ounce	= $18.56329

SILVER.

070 = same as 7—1 place right	$0.0905
002 =	.0025
072 =	$0.0930

Value of gold per ounce	$18.5632
Value of silver per ounce	.0930
Total value per ounce	$18.6562

These results, multiplied by the number of ounces and decimals of an ounce the bar weighs, would be its value in dollars and cents. Suppose the bar weighed 100 ounces:

Value of gold	$1856.32
Value of silver	9.30
Total value	$1865.62

The following must be stamped on the bar before it can be sold:

Number of the assay; name of assayer; weight of bar in ounces and decimals; fineness of gold; fineness of silver; total value of the bar in dollars and cents.

When several assays of gold bullion are to be made together, the plan of operation is somewhat modified. Let it be required to conduct nine assays together. Certain tools and appliances will be necessary which have not yet been described.

A piece of hard wood is made about four inches square and an inch in thickness. On one side a portion of the wood projects to serve as a handle; nine half inch holes are bored in the square part nearly through the thickness. On the under surface in each corner a small knob is screwed which serves as feet to raise the board above the table. In each of the holes is to be placed a tube of glass closed at one end. The other end of each is cut off square, and ground flat on a grindstone or emery wheel. The size of the tubes is such that they can be easily removed and replaced in the holes. The tubes are a little more than an inch long, so that they can be easily grasped with the finger and thumb when it is required to remove them from the holes.

Each of the tubes are marked with a letter of the alphabet, from A to I inclusive. This may be done with a writing diamond, or with a corner of a freshly broken file. Near each hole on the board is also stamped a letter, using the same as those marked on the tubes. For want of a better name, let this be called a "tube rack."

On commencing the assay, the bars are first stamped with the running number of the assays, to correspond with the entries in the record book of the assay office. Similar entries are then made on a small memorandum book, and to each entry letters are added, thus: No. 794, A; No. 795, B; No. 796, C, etc. The bars are then all taken to the anvil, and assay chips cut from them, or borings taken in the manner before described. The clippings from the bar stamped 794 must be put into the tube marked A, which is then placed in its proper hole; those from 795 in the tube marked B, etc. The bars are then set aside, and the tube rack taken to the balance. Here other apparatus will be required. A square block of wood, with a single hole bored in it the same size and depth of those in the tube rack, and another square piece of wood, with handle, of the same size and thickness as the tube rack, but instead of holes, nine hemispherical cavities are cut, each of which is about an inch in diameter and half an inch deep. These cavities are marked with the same letters, and in the same succession, as those of the tube rack. The tube marked A is lifted from the rack, and placed vertically in the hole in the second block, which serves for a temporary stand for it. The clippings that are contained in it must previously be poured out on a clean piece of paper, placed, for convenience, inside the balance case. After the assays are weighed out, the remaining gold is put back into the tube. The assays, in their leaden envelopes, are placed in the cavity marked A. B is then treated in the same way, and so on through the whole set.

Nine cupels are then marked and placed in the muffle in the same order and with the same letters. The object of marking the cupels is, that it is sometimes necessary to change their position in the muffle, and even to take one or more of them out, before the others are finished.

The manner of marking the cupels is as follows: Some red chalk is ground fine, mixed with water, and kept in a small wide mouthed bottle for use. When required to mark cupels, the contents of the bottle are mixed and applied with a small camel's hair brush. The cupels should be marked on two sides.

When the cupels are taken from the muffle, they are placed in a rack of sheet iron divided into nine compartments, and when the buttons are removed they are placed back into the cavities in the board from which they were taken when placed in the cupels. This serves to convey them to the balance, when they are weighed, alloyed with silver, and returned to the muffle for second cupellation. It will be seen that to this stage the assays are always kept in compartments bearing their mark, and with ordinary care no mistake can occur.

When the assays are alloyed with silver and rolled out, the proper letter is stamped on the end of each, somewhat deeply. The assay is then rolled up in spiral form in the usual manner, commencing at the end which is not stamped. This letter will be as distinctly seen after boiling in acid as before. The cornets are then placed in flasks, boiled with acid, and dried in the usual manner.

It has been recommended to place all of the cornets in one flask, and, after boiling, to invert it in a somewhat capacious dish of water; to pick out the cornets with a pair of forceps, and to anneal them altogether in the muffle on a tile. I have never tried it, but I consider it to be unsafe, as with the best of care the cornets are sometimes broken in the boiling. The elegant plan of boiling a number of cornets in baskets of platinum wire, in one vessel, is open to the same objection.

Before attempting to make a gold bullion assay, the following sources of errors should be known:

First, Those errors which may result from the non-adjustment of the balance and weights. If the balance is sufficiently delicate, *most* of the errors may be disregarded if the weights are always placed in the same pan; and *all* of them by counterpoising, which has already been described. Such weighing will do in extreme cases, but no assayer should be without a first-class balance.

Any convenient unit divided into 1000 parts may be used in the bullion assay. For gold assays the unit is usually one half gramme so divided, while for silver, being less valuable, one gramme is used. It is not safe to trust the weights of any maker, no matter how celebrated he may be, but the assayer should test their accuracy for himself.

Another source of error is a slight loss of gold on the cupel. This error may be corrected by cupelling a proof in the muffle at the same time with the assay. The proof is pure gold and silver, as near the composition of the assay as can be made. The loss of the proof is supposed to be equal to that of the assay and is to be added to its weight.

The manner of using the proof is as follows: First consider what will be the average fineness of the assays being conducted. The preliminary assays will furnish the data. Let it be supposed that this average will be .950, weigh out 950-thousandths of pure gold, alloy it with two and a half its weight of silver, and cupel it in the muffle with the nine assays, boil with the same acid, and under exactly similar circumstances, heat to redness in a dry cup and weigh. It will generally be found to have increased in weight, owing to the surcharge being in excess of the mechanical loss. What the proof has gained in weight must be subtracted from the other assays; when many assays are to be made from the same mine, an alloy of copper, silver, and pure gold must be made up as nearly identical as can be with the composition of the bullion, and this alloy used as a proof. Of course a full unit must be employed in this case.

A third error may result from using an impure acid, causing a loss of gold, from its solubility in nitric acid containing chlorine. This error may be avoided by always having a little silver dissolved in the acid. It is too expensive and wholly unnecessary to employ chemically pure acid in the gold assay. Good commercial nitric acid, treated in the manner to be described, will answer every purpose. Acid of two grades of strength must be prepared from the strong acid; one of twenty degrees Baumé, and one of thirty degrees. It is best to dilute all the acid to thirty degrees with distilled water, and to add a few drops of a solution of nitrate of silver. Let it remain twenty-four hours to settle, and add a few more drops of silver solution. If no cloudiness appears, the diluted acid is allowed to stand covered for a week, and the clear portion decanted from the slight precipitate of chloride of silver. One third of the acid is then diluted with distilled water to twenty degrees. The process of diluting is easily performed by the aid of a hydrometer. A portion of the acid is poured into a cylinder deep enough to float the hydrometer, which will sink to a certain point according to the density of the acid. The strength in degrees can be read on a scale on the inside of the stem.

Every assayer should possess a hydrometer and cylinder, and dilute his acid himself. The acid so prepared should be distinctly labeled, and the fact of its containing silver noted on the lable. It should be used for no other purpose.

Still another error to be guarded against is the surcharge, which is the small amount of silver which always remains in the cornet, no matter how carefully the manipulations may be conducted. There are several tables computed to correct this. The finer the gold the greater will be the surcharge.

The following results were obtained by a series of careful experiments in the Paris mint, by weighing out accurately gold and silver, both absolutely pure, to represent the fineness written in the first column. The results in the second column show the surcharge when they are greater than the fineness, and the loss on the cupel when they are less. The assays were:

900	900.25
800	800.5
700	700.0
600	600.0
500	499.5
400	399.5
300	299.5
200	199.5
100	99.5

Pure gold for proofs may be obtained in the manner described under the head of the chemistry of gold. The pure metal should be melted, rolled out thin, cleaned from oil, cut into shreds, and kept in a clean bottle for use.

There are a few points to be borne in mind in making the bullion assay to insure success. The alloy of gold and silver should not be rolled out too thin, as it is likely to be broken when this precaution is disregarded. The cornet must never be weighed without being heated to redness. Simple drying will not give correct results. In boiling with acid, the flasks should be turned on their sides at an inclination of 45° to prevent loss of acid in the event of sudden ebullition. A graduated measure should be used for the acid, that the amount put in each flask shall be equal. Common water should never be used in washing the cornet, as chloride of silver is formed in the pores of the gold, which cannot be removed, and which being insoluble in acid remains in the cornet and gives incorrect results.

MECHANICAL ASSAY OF SANDS CONTAINING GOLD, OF CRUSHED QUARTZ, OR OTHER ORE CONTAINING FREE GOLD. BASED UPON COMMON PAN-WASHING OR PROSPECTING.

As this assay is of the utmost practical value to the miner, I shall describe it with minuteness.

It must be understood that this is only a working test. It does not give all the gold in the rock, as shown by a careful fire assay, but what is of equal importance to the mine owner, mill-man and practical miner, it gives what he can reasonably expect to save in a good quartz mill. It is really milling on a small scale. It is generally very correct and reliable, if a quantity of material be sampled. The only operation which requires much skill is the washing, generally well understood by those who are most likely to avail themselves of the instruction. These rules apply equally to placer gravels. Take a quantity of the ore—the larger the better—and spall it into pieces of less size than an egg. Spread on a good floor and, with a shovel, mix very thoroughly; then shovel into three piles, placing one shovelful upon each in succession, until all is disposed of. Two of the piles may then be put into bags. The remaining pile is spread out on the floor, mixed as before, and shoveled in the same manner into three piles. This is repeated according to the quantity sampled, until the last pile does not contain more than thirty pounds of ore. As the quantity on the floor becomes smaller, the lumps must be broken finer until the last, when they should not exceed an inch in diameter. What remains is removed to an iron slab and, by the aid of an iron ring and hammer, reduced to the size of peas. The whole thirty pounds is then spread out, and after careful mixing, portions are lifted with a flat knife—taking up the fine dust with the larger fragments—until about ten pounds have been gathered. This quantity is then ground down fine with the muller, and passed through a forty-mesh sieve. If the rock is rich, the last portion will be found to contain some free gold in flattened discs, which will not pass the sieve. These must be placed with the pulverized ore, and the whole thoroughly mixed, if the quantity is small; but if large, must be treated separately, and the amount of gold calculated into the whole ten pounds, and noted when the final calculation is made.

From the thoroughly mixed sample two kilogrammes (2,000 grammes) must be carefully weighed out. This is placed in a pan, or, better, in a batea, and carefully washed down until the gold begins to appear. Clean water is then used, and when the pan and the small residue are clean, most of the water is poured off and a globule of pure quicksilver (which must be free from gold) is dropped in—a piece of cyanide of potassium is also placed with it. As the cyanide begins to dissolve a rotary motion is imparted to the dish—best done by holding the arms stiff and moving the body. As the mercury rolls over and plows through the sand, under the influence of the cyanide, it will collect together all the particles of free gold.

When it is certain that all is collected, the mercury may be carefully transferred to a small porcelain cup, or test tube, and boiled with strong nitric acid, which must be pure. When the mercury is all dissolved, the acid is poured off, more nitric acid applied cold, and rejected, and the gold then washed with distilled water and dried.

The object of washing with acid the second time is to remove any nitrate of mercury which might remain with the gold, and which is immediately precipitated if water is first used.

The resulting gold is not pure, but has the composition of the natural alloy. Before accurate value calculations can be made it will be necessary to render the gold pure and weigh it carefully.

To purify the gold, it must be melted with silver, rolled out, or hammered thin, boiled twice with nitric acid, washed, dried, and heated to redness. The manner of doing this has been fully described.

The method of calculating this assay is very simple. It will be observed that 2,000 grammes were weighed out. Let the 2,000 grammes represent a ton of 2,000 pounds, then each gramme will be equivalent to a pound avoirdupois, or one two-thousandth part of the whole, and the decimals of a gramme the decimals of a pound. Suppose the ore yielded, by the assay just described, fine gold, weighing .072 grammes, it must be quite evident that a ton of the ore would yield the same decimal of a pound. Now, as a pound of gold is worth $301 46, it is only necessary to multiply this value by the weight of gold obtained in grammes and decimals to find the value of the gold in a ton of ore—$301 46×.072=$21 70.

Care must be taken in this assay to keep the cyanide solution rather weak, as gold is somewhat soluble in strong solution of cyanide of potassium, and to remember that cyanide is deadly poison which should be handled with great care.

BLOWPIPE ASSAY OF GOLD DUST OR GOLD BULLION.

A person skilled in the use of the blowpipe, possessing a good balance, can make perfectly accurate assays of bullion or gold dust, but the results will only approximate, unless the whole lot is melted into a bar; as this, however, is not always convenient, the following plan may be adopted:

Pour the gold dust out on a large and perfectly clean sheet of paper, and with the ends of the fingers, mix it thoroughly, occasionally lifting the edge of the paper to throw it together, and again mixing to insure uniformity; then, from various parts, lift small portions, until more than an ounce is collected—this is best done with a flat knife, or by pinching with the thumb and forefinger—from this, weigh out accurately, an ounce troy; place this in a small crucible, add a little borax, carbonate of soda, and nitrate of potash, and melt the whole together—this may easily be done in a blacksmith's forge or in a coal stove—when perfectly melted, set the crucible aside, and when cold, break and remove the gold button; this must be freed from clay and slag by light blows of the hammer on its edges, and subsequent washing. When perfectly clean and dry, weigh again. The loss is water, iron, sand, mercury, and other impurities which may be assumed to be the average of the entire lot. Cut off a small portion from each side with a cold-chisel, wrap the pieces in paper to prevent them from flying, and hammer down on the anvil until thin enough to cut with scissors; place upon charcoal and heat with the blowpipe flame until the paper is burned away, taking care not to melt the gold. Cut with a pair of shears sufficient to weigh exactly the tenth of a gramme, or one hundred milligrammes; a portion should be taken from each of the pieces. The weighing must be conducted with the greatest accuracy, for the success of the assay depends upon precise manipulation.

Blowpipe cupels are made of the finest washed bone ash, formed in a cupel mold of boxwood or ebony, hammered with sufficient force to make them compact, and well dried. They are about half an inch in diameter, and less than that in height. For convenience, they may be supported in a ring of platinum wire, in a handle of cork, or fused into a glass rod, as described in works on the blowpipe.

The assay is continued as follows: Place the assay in the center of a piece of lead foil about half an inch square; fold the lead over the gold, and with the fingers carefully form it into a ball and set it aside. Prepare two assays like this. Take the cupel support in the left hand, and, having lighted a spirit lamp, lift one of the cupels by placing the end of the forefinger in the concave part, and holding it lightly with the thumb, place it in the loop of wire. Heat the cupel by urging the whole of the flame upon it, producing in doing so a roaring sound. This is best done by holding the point of the blowpipe outside the flame. When the cupel is hot enough, which is known by its becoming white after first blackening, lift with the pliers one of the assays and place it in the center of the cupel. A steadily-pointed blue flame must then be directed upon the assay until it melts and begins to oxidize, when the flame is changed to a roaring blast, and the cupel moved further from the lamp. Cupellation goes on rapidly if the flame is directed against the cupel beyond the assay, and not directly upon it, and if the cupel is kept cool—that is to say, at the lowest temperature at which the lead can be kept fluid. It will be found advantageous to discontinue the flame for an instant occasionally, and to direct it by short puffs at times. The exact point can only be attained by removing the cupel from the lamp, and returning it gradually, as may be required. As the cupellation goes on, the bead becomes more spherical; little patches of lead oxide form and pass to the cupel, becoming thinner, until at last the gold bead can be seen through the slight film of oxide. When nearly finished, the molten gold spits up toward the flame. At last, at the proper moment, learned only by practice, an instant cessation of the blast causes a flash, and a bright yellow golden bead remains on the cupel. When cold, the bead is removed from the cupel with pliers, and placed flat side down on a clean piece of paper. It is then grasped with a large pair of pincers and squeezed by a strong pressure. This generally removes all adhering bone ash, and renders the button fit for weighing. To make sure, turn it over, examine with the magnifying glass, and brush with a small short-bristle brush. If anything should be found attached to it, a squeeze at right angles with the first will generally remove it. Place the button in the pan of the balance and weigh it carefully. Its weight in milligrammes is the total fineness in hundredths. For instance, seventy-four milligrammes would be 740 fine. With a delicate balance, thousandths can be weighed, each tenth of a milligramme being .001.

The button will probably contain silver. To ascertain the fineness of gold it must be subjected to a second process. The weight of the bead being noted, a cavity is made in a piece of charcoal, held by means of a proper support. In the cavity is placed the gold button, with four or five times its volume of pure silver, and both metals are melted together, before a strong blow-pipe flame. The alloy must be thoroughly fused. When cool, it is wrapped in paper, hammered flat, heated red hot, to burn away the paper, cleaned with the stiff brush, placed in a test tube with nitric acid, and boiled over a spirit lamp until no more red fumes are given off. A black powder, which is gold, will remain. The tube is then filled up with distilled water, which is poured off carefully, so as not to permit any of the finely divided gold to pass away with it. This must be repeated, and the tube filled full for the third time with distilled water. A porcelain cup is then placed over the tube, like a cap, and both inverted together. The gold falls to the bottom of the cup, and the tube is carefully removed. The water is then poured from the gold in the cup, which is first subjected to a gentle heat, and then made red hot by the aid of the blow-pipe. During the process the cup may be held, by the aid of pincers, over the flame of the spirit lamp, which is urged upward against it from below. When the gold has assumed its metallic color the operation is finished. When cold, the gold is brushed into the pan of the balance, and its weight, in tenths of a milligramme, noted. The results may be written as follows: Suppose the weight of the cupelled button, in milligrammes, to be 74.4, the total fineness will be 744; weight of gold powder, 69.2=692; fineness of silver, 52. Or, fineness of gold, 692; fineness of silver, 52; total fineness, 744.

It is important in estimating the value of purchased gold dust, to carefully examine, to see if there is any counterfeit, or, as it is called, "bogus" dust present. If all from the same locality, the dust will have a uniform color. Any suspicious looking pieces should be set aside and cut with a cold chisel while lying on a small anvil. A fair sample of the whole lot of gold dust under examination should then be placed in an evaporating dish, the suspected pieces being placed on top, and nitric acid poured over them. If any reaction takes place, such as effervescence, or evolution of red fumes, or if the acid becomes colored, there is foreign matter present, and should this be the case adulteration or counterfeit gold dust may be suspected.

Place two watch glasses, one on a piece of white paper and the other on black, or other dark color; then, with a glass rod, convey a few drops of the acid from the dish to each. To the white add a drop or two of ammonia, until it smells strongly ammoniacal; a blue color indicates copper. To the other add hydrochloric acid in the same manner. If a white, curdy precipitate forms, which does not dissolve upon the addition of water, silver is being dissolved from the gold dust in the evaporating dish. If the dust is of very low grade, these metals may dissolve in very small quantities. But such gold dust would be easily detected by its inferior color and appearance.

If no action is observed, even after heating the dish, there is no counterfeit present. Counterfeit gold dust is sometimes so heavily coated with pure gold (by the galvanic process) as to protect the base alloy from the action of nitric acid, hence the necessity of cutting all suspected pieces before submitting to the action of the acid. To remove the acid from the gold, wash with water thoroughly, and dry over the spirit lamp.

TO TEST GOLD DUST BY TOUCHSTONE AND TEST NEEDLES.

Select from the samples several pieces, to represent as fair an average as possible, and divide each of them with the cold-chisel. Then with each piece, using the fresh cut edges, make parallel marks on the touchstone, and lay the pieces of gold on the table in the same succession. Wet the gold streaks on the stone with nitric acid, using a glass rod or the stopper of a coin test. If no reaction takes place, and the streaks look as bright and metallic as before, the gold is at least 640 fine, and probably finer even than that; wipe the stone gently with a piece of soft rag, and apply test acid in the same manner; if there is still no reaction, the gold is finer than 750; if any action is observed, the fineness is between the two. Test acid is made by mixing ninety-eight parts of pure nitric acid of thirty-seven degrees Beaumé with two parts of hydrochloric acid of twenty-one degrees, and twenty-five parts of distilled water by measure. If the golden streaks are not acted on by nitric acid, nor by the test acid, take a touch needle marked 700, and make a similar streak on the stone below that made with the samples. Compare the color, and then progress with other needles, both copper and silver, using a higher mark each time, until a color corresponding to that of the samples; an approximate knowledge of the quality of the gold will thus be obtained.

But, should nitric acid cause any change in the appearance of the streaks on the touchstone and the preliminary test in the watch glass indicated copper, try the copper needles and apply them in the reverse order until you hit the color, and find a needle, the streak of which is acted upon in a similar manner by nitric acid. If silver was indicated, use the silver needles. Considerable practice and a good eye are required to obtain accurate results with the touchstone, but this is soon acquired.

Gold dust and retorted amalgam should also be examined for mercury. This is done by putting a small fragment into a glass tube, closed at one end, observing that it falls quite to the bottom. Place the end of the finger loosely over the opening, and heat the closed end of the tube where the piece of gold lies, in the flame of the spirit lamp. If mercury is present, a bright ring will form in the tube above the assay. Upon examination with a magnifying glass, the ring will be found to be minute globules of mercury. To be certain, make a scratch with a file below the ring, and break off the closed end of the tube. Place the end of the now open tube into a few drops of water in a watch glass, and then, with a feather, or small stick, the sublimate may be brushed into the water, and by gently shaking, be caused to coalesce into a single globule, in which form it cannot be mistaken for any other substance.

HISTORY OF GOLD.

History shows that the desire to possess gold has led to nearly all the important events on record, from the day the Argonauts sailed from Greece seeking the fabled "golden fleece," to the present. The foundation of the grand science of chemistry was laid by the alchemists, whose only thought was to create gold.

The precious metal is first mentioned in the Bible in the second chapter of Genesis, and the eleventh verse, in which is mentioned the country of Havilah, "where there is gold and the gold of that land is good." In the twenty-fourth chapter of the same book it is related that the servant of Abraham gave to Rebecca an earring of gold, a pair of bracelets of the same precious metal, and ten shekels weight of gold. Long before man had gained sufficient knowledge of metallurgy to reduce the metallic ores, he had found and made use of the few metals which occur in nature in a metallic state. Gold was very abundant when there were but few uses for it.

Gold, copper, possibly silver, and perhaps iron in small quantities, which occurs in meteorites, were the first metals known to man. It required successive ages of experience and experiment before the oxidized ores were known to contain the useful metals.

The ancients had comparatively few uses for gold aside from ornament. When Brazil was first discovered, the inhabitants were unacquainted with iron and used fishhooks of gold. Even in early times, gold was drawn into fine wire and woven into cloth of gold. An ancient writer mentions having seen Agripina, wife of Claudius, seated by his side, during a naval engagement, clothed in "a robe of gold." If writers do not deceive us, gold was collected in large quantities at the great centers as it is at the present day; at Babylon in the reign of Semiramis, at Jerusalem under Solomon, at Sardis in the reign of Crœsus, again at Babylon under Darius, at Alexandria, and at Rome when she was in the zenith of her power.

In collecting the enormous quantities of gold and silver, as related in history, the ancients undertook mining enterprises which, in point of magnitude, would quite equal those of the present day. In early history we find descriptions of placer mines like those of California, and quartz veins very similar to those we are now working.

Cadmus, who is supposed to have lived in the sixteenth century before Christ, worked the first mine of copper and gold in Pangæus. More than 1,000 years afterwards, Philip of Macedon reopened and worked the same mine. A new mining town sprang up, mushroom like, as mining towns grow in modern times. The new town was called Philippi, from the great mining magnate of the period. Great stores of gold and copper were taken from mines lying on the borders of Ethiopia and Egypt, by the Pharaohs; the mines in Siberia were worked in remote ages by a people who had not yet acquired the use of iron. These mines were situated on the southern and eastern slopes of the Ural Mountains. It is the opinion of high historical authorities that from these mines the Scythians obtained their gold, as stated by Herodotus. Ancient gold hunters found a reward for their labors at Thasos, and other Greek islands. It was at Thasos that Herodotus saw a mountain which had been undermined and caused to sink. He noticed, also, what we observe at the present day, that gold was abundant only in barren mountains, which were fit for nothing else. Pliny visited a mine in Italy in which 5,000 men were employed. Arabia produced remarkably fine gold. Pieces of large size and bright color were used by artists as settings for the finest and most costly precious stones, and to make the most beautiful ornaments. The coin of the ancients was made of native unrefined gold. The ancients certainly were aware of the property of gold which causes it to amalgamate with mercury, and they took advantage of the knowledge to extract the precious metals from other substances not possessing that property, very much as we do now. Amalgamation is generally supposed to have been invented in the sixteenth century, but the following quotation, from the writings of Pliny, shows that it is much older: "Hence it is, too, that when copper has to be gilded, a coat of quicksilver is laid beneath the gold leaf, which it retains in its grasp with the greatest tenacity." Vitruvius describes the method of recovering gold from *cloth of gold* by treating it with mercury, and subsequent distillation of the mercury.

WEALTH OF THE ANCIENTS.

As an illustration of the prodigality of the ancients in the use of gold, we find it stated in the tenth chapter of First Kings, that Solomon received 666 talents of gold in a single year. The Hebrew talent being 93¾ pounds avoirdupois, this income amounts to 62,437.5 pounds, or over thirty-one tons; how he disposed of it may be found in the same book. Crœsus is said to have been worth $16,524,000 of our money; Seneca, $17,010,000; Tiberius, $95,372,640.

It is stated that the gold washings of the river Pactolus furnished the gifts sent by Crœsus to Delphi, as seen and described by Herodotus.

His offering at Branchidæ was equal to that sent to Delphi. Pytheus, a Lydian, offered to lend to Xerxes gold equal to the value of $19,965,000 of our money.

The Persian treasury contained at one time an enormous quantity of gold coin. Close to the head of the king's bed was a chamber which contained 5,000 talents weight of gold; this was called the "King's Pillow." At the foot, in a smaller chamber, 300 talents of silver were kept.

Around the miner's camp fire conversation naturally leads to the all absorbing subject of gold and its origin. Each prospector has a theory of his own, but all are based on the vague idea that gold in the placers is brought from some general source, which the miner searches for, but never finds. What is true of the present was true in early times. It was the universal belief, as far as we have history, that if the source of gold be found it would be possible to quarry it out like granite, but this idea seems never to be realized.

"El Dorado" is Spanish for "golden region." Three hundred years ago Francis Oreliana, a companion of Pizarro, conceived the idea that gold found in the valleys must have been washed down from some vast deposit in the mountains. He spread the report that he had discovered such a deposit near the summit of the Andes, which he called "El Dorado." He described it as being a valley, beautiful, not only for its scenery, but for its streams and fountains, grassy slopes, and groves of pines and cedars. A vail of enchantment hung over the valley; the trees were graceful; the skies were never obscured by clouds, and gold and gems were as plentiful and common as rocks and pebbles in other lands. He said he had seen at Manoa immense treasures of gold and precious stones, brought from "El Dorado," and temples roofed with gold. Oreliana is said to have discovered the Amazon in 1549.

After the Spanish conquest the existence of the enchanted land was generally believed. It was supposed to be a natural storehouse, so vast that the mineral wealth of Peru was but a trifle in comparison. It was supposed to lie between the Oronoco and the Amazon. The word El Dorado has now passed to poetry. When Cortez conquered Mexico in 1519, the Spaniards forcibly collected all the gold and silver in the hands of the natives and sent it to Spain. The same thing was done in Peru in 1527 by Pizarro. The conquerors not only took all the precious metal already extracted, but forced the Peruvians to work in the mines for more.

PHYSICAL PROPERTIES OF GOLD.

There is probably no metal more generally distributed over the earth's surface than gold, but its physical properties are such that it can only exist in comparatively small quantities within the reach of man. Iron and most other metals have such an affinity for oxygen that they form compounds with that element, becoming oxides, which form secondary compounds with other elements and compounds and become part of the rocks which constitute the earth's crust; gold, and a few other metals, having little or no affinity for oxygen, and for that reason called "noble metals," retain their metallic state and are seldom found otherwise.

The value of gold can only be measured by the labor expended in its production. If gold was as plentiful and as easily obtained as iron it would have no greater value. By common consent, the world has accepted the theory that gold must possess a fixed standard value and that the value of everything must be measured by it, while in reality, gold fluctuates like all other commodities, being governed by the same law of supply and demand. When the supply increases, as when new fields like those of California and Australia are discovered, everything else rises in price, which is equivalent to a fall in gold. Chevalier, of Paris, who wrote a remarkable work on the precious metals, about the date of the discovery of the gold fields of Australia, predicted a fall in the value of gold, which actually occurred. Jacobs, another celebrated writer on the same subject, has shown that in every case of the discovery of new gold fields, or rich and productive mines of silver, recorded in history, the prices of all other things have risen in exact proportion.

Dr. Trask, first State Geologist of California, published a statement, which is quoted by Chevalier, to the effect that the average value of the gold collected by a California miner, in the year 1854, was three dollars and thirty-five cents per diem, while the laborer who washed the sands of the Rhine in the same year could only collect the value of twenty-eight cents per day, and that it was for this reason, and no other, that wages were higher in California than in Germany.

The love of gold is, without doubt, the result of education. As an example, a savage in possession of a gold coin will willingly exchange it for a nail or a fishhook. Even those knowing the value attached to gold will receive a counterfeit with perfect satisfaction and retain it until its true character is discovered. When the ports of Japan were first opened to Europeans, the relative value of gold to that of silver was less than with us, which was taken advantage of with serious loss to the Japanese. Those who think that gold is valued for itself alone have neglected the study of political economy, and should be told the story of the man who, for a wager, undertook to sell sovereigns at a shilling a piece on London Bridge and found to his surprise that he could not find a customer.

The color of pure gold is bright yellow, tinged slightly with red. It has a higher luster than copper, but less than silver, steel, mercury, or platinum. It is softer than silver, and more ductile and malleable than any other metal. Although its malleability is so remarkable when pure, it is rendered brittle by the slightest admixture of lead. It also becomes so when suddenly cooled. When passing from a liquid to a solid state it contracts more than any other metal. The atomic weight of gold is 196.5, hydrogen being taken as unity. It fuses at a temperature of 2016 Fahrenheit. Gold may be distinguished from all other substances by the following simple and characteristic tests: *It is yellow; is not acted on by nitric acid, and it fuses to a bright bead on charcoal without incrustation.* In sufficiently large pieces, it may be recognized by being *malleable under the hammer, and cutting with a knife without crumbling.*

Gold, when alloyed with other metals, cannot be so easily distinguished, as its associates somewhat modify the reactions. The color of native gold is degraded by metals with which it is alloyed. In some localities it is found pale from admixture with silver, and in others red from the presence of copper.

According to Berthier, the specific gravity of gold is 19.258, which may be increased to 19.376 by hammering. In a melted state it is said to assume a bluish-green color. I have never observed this property of gold. Its tenacity is lessened by hammering or rolling, but it may be restored by subjection to sufficient heat.

Gold leaf is green by transmitted light, but it becomes red when strongly heated. In red gold glass, the metal is said to be in the metallic state. Gold does not oxydize at ordinary temperatures, nor in the hottest furnaces. A slight oxydization takes place when it is exposed in thin leaves to the action of the compound blowpipe, or to a powerful galvanic battery. In a vacuum the electric spark divides it into a very fine powder. Gold is less tenacious than copper, iron, platinum, or silver. A wire of gold only the .078 of an inch in diameter will not break until loaded with a weight of 150 pounds. In cooling after fusion gold forms crystals. Gold is not the most beautiful metal, nor is it the best fitted for all the uses to which it is applied, it being found necessary to alloy it with other metals for certain purposes.

Gold powder or bronze is made by grinding gold leaf in a mortar with honey, extracting the honey with hot water, and drying the powder. It is used in illumination and miniature painting.

Gold is extensively used in the arts. More than 1,000 ounces of pure gold are consumed in Birmingham alone every week, and in the whole of England the weekly consumption of gold leaf is 584 ounces, while for electro-gilding and other uses 10,000 ounces are required annually. Two pottery establishments use $35,000 worth of gold per annum, for gilding porcelain and for making purple and rose colors. Nearly 10,000 ounces of gold are consumed by the Staffordshire potteries annually. Gold has become so plentiful that but few persons are met who do not have this metal about their person, either as coin, jewelry, or timepiece. The amount of gold used and lost in ornament is beyond calculation.

Professor Albert A. Chester, of Hamilton College, has published the method of preparing the extremely malleable gold foil now almost exclusively used by dentists, which is quoted below:

The precipitation of gold from solution by the aid of a battery, is a well known process in the common operation of electro-gilding, but to deposit it in the crystalline form is a process of comparatively recent date, having been patented in 1860, as a method of preparing gold for dental purposes. The process is briefly as follows: A solution of chloride of gold and ammonium is placed in a shallow dish coated with heavy gold foil, which is connected with the zinc plate of a large Daniells' battery. Near the top of the solution, and connected with the copper plate of the battery, a roll made up of thin strips of pure gold is suspended, inclosed in a muslin bag. The strength of the battery current is controlled by a coil of wire arranged as a rheostat, a clamp terminating one of the battery wires enabling the operator to include a greater or less number of coils in the circuit. The necessary conditions being fulfilled, on completing the circuit the gold is gradually dissolved from the roll and deposited on the bottom of the dish in bright crystalline flakes, having the appearance of feathers or fern leaves when examined under the microscope.

Native gold is usually found in scales, threads, plates, and irregular masses, from a few grains in weight to many pounds. Although generally amorphous, it is frequently found in crystals, which usually assume some modification of the octahedron. Crystals of gold are never found large. Beautiful microscopic octahedral crystals of gold are found in the Ida mine in Inyo County, California, and at the White Bull mine, Linn County, Oregon. Many substances are mistaken for gold. Some varieties of mica resemble it in certain lights, so much as at times to deceive the most experienced eye. Chalcopyrite or copper pyrites, or even iron pyrites, are sometimes mistaken for it; and wulfenite or molybdate of lead, quite common in Nevada and Eastern California, bears a perplexing resemblance to it.

Most of the best paying mines in California do not produce rock in which gold is visible to the naked eye. It requires long search to find a piece of rock showing free gold. When the tailings of a quartz mill are examined microscopically, the importance of reducing the ore to a state of extreme fineness will be apparent, for if gold is not absolutely free it cannot be collected by mercury. It must be admitted, from the experience of the last thirty years, that gold exists in minute quantities in many rock formations, which will not pay to work. On the other hand, many mines, which will scarcely pay at the present time, will become productive as our quartz milling machinery is improved. Much gold is lost in California by unskillful milling. Gold is generally found native or alloyed with some other metal. Very few ores contain it in such form as to be regarded as mineral species.

One grain of pure gold is worth $0.0430663; one gramme pure gold is worth $0.6646+; one ounce troy gold is worth $20.671791; one pound avoirdupois gold is worth $301.46+; one ton (2000 lbs. =29166.6 oz. troy), $602,927.36; one cubic inch (10.12883 oz. troy), $209.38; one cubic foot, (17579.9808+ oz. troy), 1205.4898 pounds avoirdupois; value, $363,409.85. The standard fineness United States gold coin=900; one cubic inch of standard gold, 9.0989 oz.=$169.28; one cubic foot standard gold=$292,500.00. The average specific gravity of California gold dust, as it would be in a box or bag, was found by the United States Mint to be 9.61. It occupies about twice as much space as when melted into bars. A rectangular box, eight by ten inches and five inches deep, will contain 36,000 dollars in gold coin laid in order, and 27,000 dollars poured in and shaken. A bag six inches by nine inches will hold 5,000 dollars in gold coin with room to tie.

The difference in the fineness of California gold may be seen by the following table of analyses made by some of the first chemists of the United States and Europe. Professor J. D. Whitney gives the average fineness at 875 to 905, while Professor Wm. P. Blake states it at 865 to 870.

Gold—Per cent.	Fineness.	Silver. Per cent.	Fineness.	Copper. Per cent.	Iron. Per cent.	Silica. Per cent.	Total.
75.86	758.6	20.67	206.7			2.44	98.97
86.57	865.7	12.33	123.3	0.29	.54		99.73
86.87	868.7	12.33	123.3	.29	.54		100.03
88.75	887.5	8.88	088.8	.85	trace.	1.40	99.88
89.10	891.0	10.50	105.0		.20		99.80
89.61	896.1	10.05	100.5				99.66
90.01	900.1	9.01	090.1		.86		99.88
90.33	903.3	6.80	068.0		1.10		98.23
90.70	907.0	8.88	088.0		.38		99.88
90.90	909.0	8.70	087.0		.20		99.80
90.96	909.6	9.04	094.4				100.00
92.00	920.0	7.00	070.0				99.00
92.70	927.0	6.90	069.0	0.40			100.00
93.53	935.3	6.47	064.7				100.00
96.42	964.2	3.50	035.8				100.00

Average—996.05.

ALLOYS OF GOLD.

Gold alloys readily with most metals, the various compounds having physical properties almost characteristic as distinct elements. This is the case more especially when the metals are combined in chemical equivalents.

The only alloys of gold which find extensive use in the arts, are those of silver and copper, pure gold is too soft and too costly a metal to be suitable for coin or for manufacturing purposes. It is therefore hardened by the addition of other metals.

Jewelers' gold is alloyed to suit the purposes for which it is required. The following are some of the alloys, with the technical names given to them:

Yellow gold, pure gold	1000	Rose copper	----	Silver	----
Red gold, pure gold	750	Rose copper	250	Silver	----
Green gold, pure gold	750	Rose copper	----	Silver	250
Dead leaf, pure gold	700	Rose copper	----	Silver	300
Water green, pure gold	600	Rose copper	----	Silver	400
Blue gold, pure gold	750	Iron	250	Silver	----

White gold contains silver in excess.

Alloys are also made by the jewelers, and the manufactured articles acted on by acids. The surface becomes pure gold, and the composite nature of the alloy is dishonestly concealed. The solution said to be used for this purpose, is a mixture of two parts of nitrate of soda, one part of chloride of sodium, one part of Roman alum, in three or four parts of distilled water. The articles are boiled in this solution until the proper shade or color is obtained, generally fifteen to twenty minutes. They are then taken out, washed and burnished.

The alloys of gold and copper are more fusible than either of the metals alone. Copper gives the alloy the required hardness.

Silver and gold form useful alloys, but are liable to separate, if the crucible in which they are melted is allowed to stand without being stirred; the alloy is harder than either of the metals. The hardness is at its maximum when the proportions are two parts of gold to one of silver. Twenty parts of gold become visibly whiter when alloyed with one part of silver. This alloy is more fusible than pure gold.

Platinum does not alloy readily with gold. To form this alloy it is necessary to fuse the metals at a very high heat, or the platinum will only be disseminated through the gold. The alloy has the color of bell metal, or tarnished silver. When the platinum is in the proportion of one sixth, the color of gold is lost. An alloy of equal parts of gold and platinum has the hardness of wrought iron. It is slightly ductile.

Gold and antimony form an alloy which has a pale, dull color; it is exceedingly brittle. The fracture is ash colored.

Alloys of gold with lead have a color from that of pure gold to white, according to the amount of lead employed. All these alloys are brittle, some as much so as glass; the alloy is brittle if only a trace of lead is present. Even the fumes of lead are said to give gold an inconvenient brittleness.

In the United States, the value of an alloy of gold is always expressed in thousandths. The coin of the United States is 900 fine, containing 900 parts of pure gold in 1,000 parts. The gold is melted with 100 parts of an alloy of nine tenths of copper and one tenth of silver, thus: Gold, 900; copper, 90; silver, 10=1,000.

In England, the gold in alloys is expressed in carats; the carat is divided into four grains, which are subdivided into quarters and eighths. Pure gold is twenty-four carats fine. The standard of gold in England is twenty-two parts of pure gold to two of copper.

It may sometimes be interesting to know the relation between the fineness of gold and its value in carats. Pure gold (1,000 fine) is said to be twenty-four carats fine; twelve carats would evidently be five hundred fine, or one half gold. The following table will show the relative value:

Carats.	Value.	Carats.	Value.
1	.041667	13	.541667
2	.083334	14	.583333
3	.125001	15	.624555
4	.166667	16	.666667
5	.208333	17	.707333
6	.250000	18	.750000
7	.291666	19	.791666
8	.333333	20	.833333
9	.374999	21	.874999
10	.416667	22	.916666
11	.458630	23	.958333
12	.500000	24	1.000000

The following table gives the properties of the alloys of gold with other metals:

Brittle Alloys and their Colors.		Malleable Alloys and their Colors.	
Cobalt	Dull yellow.	Manganese	Gray.
Nickel	Brass yellow.	Iron	Gray.
Antimony	Pale yellow.	Copper	Yellow.
Zinc	White.	Tin	Pale yellow.
Bismuth	Brass yellow.	Silver	Pale yellow.
Lead	White.	Platinum	White.
Rhodium	Yellow.	Palladium	Gray to white.
Mercury	White.	Iridium	Pale yellow.
		Osmium	Pale yellow.

Gold is not found in nature alloyed in chemical equivalents.

GOLD NUGGETS.

By far the greater part of the gold found in placer mines occurs in small grains, or "gold dust" as it is called. It is one of the peculiarities of the precious metal that no great masses have ever been found, the largest being small, as compared with known masses of copper, iron, and silver.

The following is a partial list of the most celebrated gold nuggets of modern times:

FOREIGN GOLD NUGGETS WEIGHING MORE THAN ONE HUNDRED OUNCES.

1. A mass of gold was exhibited at the World's Fair, at London, which is said to have been three hundredweight. It is stated that this specimen was brought up from a deep mine on the back of a man. If the English hundredweight is meant, it would be 336 pounds avoirdupois, or 4,899.89 ounces troy. It was brought from Chili.

2. With the exception of the Chili nugget, the largest mass of gold on record was found at Ballarat, Victoria, Australia, in 1859, and known as the "Sarah Sands." Its weight was 2,688 ounces. Of all the great Australian nuggets, those from Victoria were the largest and most plentiful.

3. Another found at Ballarat, Victoria, Australia, weighed 2,217 troy ounces, or about 185 pounds troy.

4. The Welcome nugget, also found at Bakery Hill, Ballarat, Victoria, in 1858, at a depth of 180 feet, weighed 2,195 ounces troy. A model of this magnificent specimen may be seen in the State Museum of California.

5. The Blanch Barkly nugget, which was exhibited at London, weighed 146 pounds troy, or 1,752 troy ounces. It was found at Kingowa, Victoria, and was melted in London in August, 1858, yielding gold to the value of £6,905.

6. The "Precious," found at Berlin, Victoria, Australia, weighed 1,621 troy ounces.

7. In July, 1851, a very large nugget was found in a pile of quartz, at Meroo Creek, or Louisa Creek, River Turon, fifty miles from Bathurst, and twenty-nine miles from Mudgee, New South Wales. It was in three pieces, but was considered to be of the same origin, and is reckoned as one mass. It was found by a native boy, who saw the glitter of some exposed portion. The total weight of the three pieces was 100 pounds troy, or 1,272 troy ounces.

8. A mass of gold mixed with quartz and mundic was found in 1858 at Burrandong, near Orange, New South Wales. After the quartz and sulphide of iron were removed by hammering, the gold weighed 120 pounds; which being melted at the Sydney Mint, yielded a little over 1,182 ounces of gold, 874 fine, and valued at £4,389 8s. 10d.

9. The "Ural" nugget, found in 1842, in the Valley of Taschku Targunka, near Miask, Russia, is now preserved in the Museum of Mining Engineers at St. Petersburg. Several others were found near the same locality of less size. A model of this beautiful nugget, which weighed ninety-six pounds troy, or 1,152 troy ounces, may be seen in the California State Museum.

10. The "Viscount Canterbury," found at Berlin, Victoria, Australia, weighed 1,105 troy ounces.

11. The "Viscountess Canterbury," also found at Berlin, Victoria, weighed 884 troy ounces.

12. There is said to be a mass of gold in the Museum of St. Petersburg, weighing seventy pounds; but this is probably the Ural nugget (No. 9) wrongly described; weight, 840 troy ounces.

13. The "Kum Ton" nugget, found in Victoria, Australia, weighed 718 troy ounces.

14. The "Schlem" nugget, found at Dunolly, in Victoria, Australia, weighed 478 troy ounces.

15. A mass of gold, found in Kiandra, Snowy River, New South Wales, in 1860.

16. The "Platypus," found at Sandhurst, weighed 377 troy ounces.

17. A nugget found at Forest Creek diggings, Mount Alexander, weighed 336 (?) ounces troy.

18. The "Brenan" nugget, found in Meroo creek, Turon River, New South Wales, in 1851, embedded in clay, weighed 364 troy ounces; value, £1,156.

19. The "Beauty," found at Sandhurst, Victoria, weighed 248 troy ounces.

20. The "Needful," found at Berlin, Victoria, Australia, weighed 246 ounces.

21. A gold nugget, found at New Chum hill, Kiandra, Snowy River, New South Wales, in 1861, weighed 200 troy ounces.

22. The "Crescent" found at Berlin, Victoria, Australia, weighed 176 troy ounces.

23. A golden nugget found at Kiandra, Snowy River, New South Wales, in 1860, weighed 160 troy ounces.

24. One found in 1852, at Meroo Creek, Turon River, New South Wales, called "the King of the Water-worn Nuggets," weighed 157 troy ounces.

25. The largest nugget found in Australia, in a quartz vein, was taken from Old Quartz Hill, Castlemaine, Victoria. It weighed thirteen pounds troy, 156 troy ounces.

26. A nugget was found in 1860, at the Tooloom diggings, New South Wales, which was nearly solid gold. It weighed nearly 140 troy ounces.

The following list of remarkable California gold nuggets is compiled from various sources, and probably contains errors, as many of the statements are hearsay—made from memory—years after the discovery of the specimens. It will, however, furnish a foundation for a corrected catalogue in the future.

Where the weight only has been published the value has been calculated on an assumed fineness of 900. Of course, such a calculation is only approximative, it being impossible to know the actual fineness. Where the value only has been stated, the weight has been obtained by reversing the calculation:

27. 28. The first piece of gold found in California by James W. Marshall, weighed fifty cents; and the second, five dollars. They were both paid out for provisions, and all trace of them lost. It is, therefore, impossible to show the first piece of gold found in the State, and it is to be hoped that we shall not soon see the last.

29. The discovery of the first specimen of gold remarkable for its extraordinary size, plays a prominent part in the early history of California. The official news of the discovery of gold in the State was taken to the Government by General E. F. Beale. He went to Washington bearing about fifty dollars' worth of gold dust, but failed to excite the interest he anticipated, and returned disappointed. During his absence, the historical mad rush to California from the ends of the earth had begun, and he found San Francisco in a wild state of excitement. He arrived late in the Summer of 1848. About that time a young soldier of Stevenson's regiment, while riding along the Mokelumne River, stopped to drink from a stream, and discovered a gold nugget weighing between twenty and twenty-five pounds. He hastened to San Francisco and placed his prize in the hands of Colonel Mason for safety, who sent it by General Beale to the Eastern States, the exhibition of which in New York fanned the smouldering flame, and the nation began to realize the importance of newly acquired California.

30. In November, 1854, a mass of gold was found at Carson Hill, Calaveras County, which weighed 195 pounds troy, or 2,340 troy ounces, the value of which, assuming the gold to be 900 fine, was $43,534. This is the largest piece of gold ever found in the State. Several other nuggets, weighing from six to seven pounds, were found at the same locality.

31. On the eighteenth of August, 1860, a large piece of gold was taken from the Monumental quartz mine, Sierra Buttes, Sierra County, which weighed 1,596 ounces troy, the value of which was estimated at from $21,000 to $30,000. The mine was owned by Wm. A. Farrish & Co. The nugget was sold to R. B. Woodward, of San Francisco, on the fourth of September, 1869, for $21,636 52, and placed on exhibition at Woodward's Garden, where it attracted much attention. By an unfortunate circumstance, no cast was ever made of it. It was melted and sold October seventh of the same year, yielding only $17,654 94—an example of the universal habit of overestimating the value of such specimens. The Monumental mine had yielded $70,000 worth of gold at the time of the discovery of the nugget.

32. Mr. Strain found a large slab-shaped gold quartz nugget near Knapp's ranch, half a mile east of Columbia, Tuolumne County, which weighed over fifty pounds avoirdupois; it was about fourteen inches long, nine inches wide at one end, and five at the other. The sides were nearly parallel. When broken up, gold was separated from the quartz, melted into a bar weighing 396 ounces, and sold for $7,500. The rock was then crushed in an iron mortar and panned out. The result was gold to the value of $1,000 more. This specimen was found in a small trail leading up the slope of the hill from the gulch, and hundreds of miners had walked over it without notice. Near the same locality others found pieces worth a few hundred dollars, but the pocket or vein from which it came was never discovered.

33. A nugget was found at Sullivan's Creek, Tuolumne County, in the year 1849, which weighed twenty-eight pounds avoirdupois, or 408 ounces troy, the calculated value of which was $7,590.

34. In 1855, at French Ravine, Sierra County, a nugget was found which weighed 532 ounces, and was worth $10,000. It contained considerable quartz, which is not calculated in the weight.

35. In the year 1867, at Pilot Hill, El Dorado County, a bowlder of gold quartz was found, which sold for $8,000. The estimated weight of gold was 426 ounces troy.

36. In 1851, at French Ravine, Sierra County, a gold nugget was found which weighed 426 ounces, and was valued at $8,000.

37. Mr. Virgin and two other miners found a nugget of gold on Gold Hill, near Columbia, Tuolumne County, which weighed 360 ounces. The value of the piece was about $6,500. It was somewhat oblong in shape and worn perfectly smooth. On one side there was a deep cut, as if the mass had been formed in contact with a sharp rock. The gold was bright and had the general appearance of a small meteorite. It was found two and one half feet below the surface, imbedded in red clay.

38. In 1853, a mass of gold, weighing 283 ounces, and valued at $5,265, was found at Columbia, Tuolumne County. My informant saw it weighed at Mills' banking house, in Columbia.

39. A nugget is reported to have been found at Minnesota, Sierra County, weighing 266 ounces, and valued at $5,000. No other particulars have been obtained.

40. In 1850, a piece of gold quartz was found in French Ravine, Sierra County, which contained 263 ounces of gold, worth $4,893.

41. A Frenchman found a nugget of gold in Spring Gulch, near Columbia, Tuolumne County, which was nearly pure gold. It was worth more than $5,000. The mass was somewhat coated with oxide of iron when first found. It was globular in shape. The discovery of this nugget proved to be a great misfortune, for the finder became insane the following day and was sent to Stockton. The French Consul recovered the nugget or the money obtained for it, and sent it to his family in France.

42. A nugget was found August 4, 1858, weighing fifty-four pounds avoirdupois before, and forty-nine and a half pounds after melting, at the Willard claim, on the West Branch of the Feather River. The specimen was found by Ira A. Willard.

43. A gold nugget was found—date not given—near Kelsey, El Dorado County, which sold for $4,700.

44. In 1876, J. D. Colgrove, of Dutch Flat, found a white quartz bowlder in the Polar Star hydraulic mine, which contained $5,760 worth of gold. The gold was very fine.

45. A nugget, said to have been pure gold, was taken from the Middle Fork of the American River, two miles from Michigan Bluffs, in the year 1864, which weighed 226 ounces, and was sold for $4,204. Another account of this nugget states the weight to have been 187 ounces.

46. In 1855, at Remington Hill, Nevada County, a nugget of gold was found which sold for $3,500. The weight, estimated from the value, was 186 troy ounces.

47. At Smith's Flat, Sierra County, in 1866, a piece of gold was taken from a claim which was worth $2,716, and weighed 146 ounces.

48. At Smith's Flat, Sierra County, in the year 1864, a nugget was found of 140 ounces weight, and worth $2,605.

49. No date is given in an account of a gold nugget found in a gulch near Klamath River and Groot's Ferry, Siskiyou County. Its weight is stated as 131 ounces, and its value $2,437.

50. A second piece of gold of unusual size, was found at Remington Hill, Nevada County, in 1867, which weighed 128 ounces, and was valued at $2,400.

51. In 1869, a nugget was found at Little Grizzly Diggings, Sierra County, which weighed 107 ounces, and was worth $2,000.

52. A cluster of beautiful dentritic crystals of gold was found in August, 1865, in the Grit claim, Spanish Dry Diggings, El Dorado County, which weighed 101.40 ounces troy, the value of which was $3,500. It was taken from a tunnel 200 feet below the surface. It was sold and sent to New York, where a French gentleman, Mr. Fricot, formerly of Grass Valley, bought it, and by him it was taken to Paris. In all probability it now graces some foreign museum. It should have been preserved in our own. A fine photograph of this beautiful specimen has been presented by Mr. Arthur M. Hickox to the State Museum, where it may be seen by those interested.

53. A nugget of gold weighing ninety-four ounces, was found in the Hope claim, four miles below the Mountain House, Sierra County, valued at $1,770. The name of the finder and the date are not given.

54. In 1854 a gold nugget was found by Frank Russworm, in a claim two miles south of Campo Seco, Calaveras County, at the head of Stone Cabin Gulch, on the bedrock, twenty feet from the surface. Weight ninety-three ounces, value $1,760. It was sent to the mint soon after being found.

55. In 1860, at French Ravine, Sierra County, a nugget worth $1,757, and weighing ninety-three ounces, was found.

56. In 1861, at Smith's Flat, Sierra County, a gold nugget was found, which weighed eighty ounces, and was valued at $1,509.

57. At Lowell Hill, Nevada County, in 1865, a fifty-eight ounce nugget worth $1,100, was found.

58. There is a model of a gold nugget in the State Museum from Oregon Cañon, El Dorado County. Mr. Caleb T. Fay of San Francisco, thinks this nugget is one that he bought in 1850 for $1,250 and sent to Boston, where it was placed on exhibition in the counting room of Dexter, Fay & Co. Mr. Fay will write to Boston to learn if a cast was made of it at the time. The nugget was found by Alonzo Kinsley.

59. In 1865, Paul Wallett found a nugget on the west branch of Feather river, in Butte County, near Magalia, now known as the "Red Hill Claim," worth $1,760. In the same claim in 1862, R. Morrison found a nugget worth $1,607. Morrison was supposed to have had quite a number of large nuggets, as he had shown a number from three ounces to several pounds. He was killed by the Indians, as supposed, for robbery.

60. A beautiful nugget of crystallized gold was exhibited at the Paris exposition of 1878, in the Pacific Coast collection, which attracted much attention. It weighed thirteen ounces. Its intrinsic worth was $248; but as a beautiful mineralogical specimen, it was far more valuable. It was from the Banghart mine, Mad Mule cañon, Shasta County, and was exhibited by Samuel Cooper.

61. What are known as pocket ledges are common in California. By this may be understood quartz veins, in which rich spots occur, and from which large amounts of gold are sometimes taken from a comparatively small space. No calculation can be made as to the extent of these pockets, or as to the reasonable expectation of finding another when one is exhausted. A remarkable deposit of this nature has lately been developed in the Rainbow mine, Sierra County. A fine specimen has been on exhibition at the office of H. H. Noble, in San Francisco. It was a slab of gold quartz, which was calculated to contain $20,468. It was taken from a depth of 200 feet. The whole shipment from the pocket has been 1,953 pounds, and the total yield at the time of writing, $116,337.

62—73. From 1854 to 1862, twelve gold nuggets, ranging from thirty to one hundred and seventy ounces, were taken from the Live Yankee claim at Forest City, Sierra County.

74. From 1856 to 1862, a number of gold nuggets, varying from thirty to one hundred ounces, were found in the Oregon claim at Forest City, Sierra County.

75. In Holden's Garden, in Sonora, Tuolumne County, in the year 1850, a mass of quartz and gold containing $30,000 worth of gold was found.

The following list of remarkable gold nuggets found in El Dorado County has recently been published in the Georgetown Gazette:

76. In the Summer of 1857, the Aiken brothers, mining on Manhattan Creek, two miles from Georgetown, found a nugget of gold, free from quartz, that coined $1,166.

77. In 1857, Samuel Treeworgee, mining at Garden Valley, found a slug worth $525.

78. Thomas Patten, of Placerville, informs us that, in the year 1849, or early in '50, a nugget was found in what is now known as Illinois Cañon, near Georgetown, worth $1,000. The locality was, for a long time, known as the "$1,000 Cañon." Our informant believes the piece was sold to John T. Little, then a merchant at Coloma, now a real estate and money broker in San Francisco.

79. George Beattie, of Georgia Slide, saw a nugget, in September, 1850, of solid gold, about the size and shape of a goose egg, worth about $1,000, found by a man named Jenking, in Hudson Gulch, at Georgia Slide.

80. In July, 1860, John B. Bennet and Milo Knox, now of Georgetown, found a piece of pure gold weighing two and a half pounds, worth over $500, in the well known Pennsylvania Seam Mine, at Spanish Dry Diggings, in a tunnel forty-five feet below the surface.

81. About 1854, a mass of gold, valued at about $1,100, was taken from a gulch near the Grit Seam Mine, by "Texas" and Jacobs.

82. The following is an extract from the Alta California, of recent date: "A peculiarly formed gold nugget, weighing eight ounces, was found at the Bald Mountain Mine, at Forest City, lately. The formation of the gold consists of a perfect image of a human being. The legs and feet are almost perfect, while the left hand, which possesses four fingers, lies on the breast, the right arm hanging down by the side. The head stands erect, while the whole form has the appearance of being as dignified as the Lord Mayor of London."

83. At Wood's Creek, below Sonora, Tuolumne County, in 1848, William Gulnac found a nugget which weighed 150 pounds, 75 pounds of which was gold. This information is given by Dennis Martin, who came to California in 1844.

DIVISIBILITY OF GOLD.

Recent investigation leads to the opinion that gold, in a state of extreme division, is omnipresent in the earth's crust. T. Sterry Hunt, in his work, "Chemical and Geological Essays," quotes Sonstadt, to show that the sea water on the British coast contains, beside silver, gold in solution, estimated by him to be about one grain to a ton of water. Mr. J. Cosmo Newbery, Chemist of the Geological Survey of Victoria, Australia, has made some very interesting investigations bearing on the divisibility of gold. He found that the water in certain gold mines contained gold. The timber used to support the mine was carefully assayed, and in nearly every case was found to contain gold. R. Brough Smyth, Chief of the Survey, came to the conclusion that the gold was precipitated from solution.

Mr. Newbery had reason to believe, from examination of specimens, that gold was being deposited in many mines. He thinks, however, that finely divided gold is held in suspension in mine water, but not in solution. A sample of mud deposited from mine water of a mine on Hasler's line of reef, Sandhurst, was examined, by careful washing, and the heavier particles were found to consist of auriferous pyrites and free gold. The particles of gold were large enough to be recognized by the microscope. They were in irregular flattened grains.

Dr. Oxland, who was formerly manager of the Borax Lake Company's works, in Lake County, California, has given a very interesting account of the deposition of gold with cinnabar, free mercury, sulphur, boracic acid, silica, etc., at the sulphur banks situated on the margin of Clear Lake. He says: "These phenomena present indubitable evidence of the volatility of gold and silver, mercury and iron, in presence of aqueous vapor, associated with sulphuretted hydrogen, carbonic acid, and boracic acid."

On the Pacific Coast, gold is found in the most unexpected places. There is scarcely a formation which does not contain it in greater or less quantities. It is also found with minerals not usually considered its associates.

Pure gold is the most malleable of metals, and there seems to be no limit to its ductility. A single grain has been drawn into a wire five hundred feet in length. It may be beaten into leaves which are only the 282,000 part of an inch in thickness. Reaumer covered a cylinder of silver with .002778 of its weight of gold. It was drawn into a wire, six feet in length of which weighed one grain. This wire was then rolled until it was the one forty-eighth of an inch wide, which increased its length to seventy-five feet. The coating of gold was so perfect that the microscope failed to detect the color of silver. In the days of Pliny gold was beaten so thin that one ounce was flattened into 750 leaves, four fingers square. It has been calculated that the leaves were three times thicker than ours. Gold has been beaten so thin in modern times that 367,000 leaves would only make an inch in thickness, if piled upon each other. The same number of leaves of ordinary printing paper would make a pile seventy-five feet high. Compared with the thickness of the gold on fine gilded wire, gold leaf is thick. It has been calculated that it would take 14,000,000 films, such as sometimes put on the fine wire of which gold lace is made, to equal an inch in thickness, while the same number of leaves of printing paper would make a pile 3,000 feet high. One ounce of pure gold is supposed to be sufficient to gild such a wire 1,300 miles in length.

Having had occasion to refer to statistics showing that gold coin loses an appreciable amount even in a single handling, and being desirous, in connection with certain investigations, to examine, microscopically, the gold dust resulting from such abrasions, I asked Mr. L. A. Boynton, of the United States Treasury of San Francisco, to brush out the wooden trays in which large quantities of gold coin are daily handled, and when sufficient had accumulated, to send it for examination. He kindly complied, and some interesting facts were developed.

A microscopic slide was prepared in which the gold was mounted dry, after first removing the impurities with which it was mixed—coal, sand, fibres of wood, cotton, hair, etc. In washing out the extraneous matter, the finer particles of gold floated on the surface of the water, and it was found impossible to cause them to sink, although every known plan was tried. This experiment would seem to prove the truth of the oft-repeated statement of miners, that much free gold escapes them from this cause.

On examining the slide under the microscope it was seen that the gold was invariably in the form of scales, and much resembled the natural gold scales found in the beach sand, at Cape Blanco, except that in the latter the edges and faces of the scales are rounded by attrition in being washed about by the waves.

It has been a source of wonder to gold miners that nearly all placer gold is found in flat pieces. Some ingenious theories have been advanced to account for it. This experiment would seem to indicate some law which governs the form of fragments, although it is not easy to understand how rounded masses of metal, like gold coin, can react on each other and produce flat scales as described.

Some of the particles were measured and found to vary in decimals of an inch from .003×.001 to .0425×.0235. A large number of gold scales from Port Orford were also measured for comparison, and found to average .0095 in diameter by .00384 in thickness. The samples were washed from the beach sands, found a few miles south of Cape Blanco, on the coast of Oregon. Ten of the scales, selected at random, and melted into a button, weighed .002 grammes. From this weight is calculated the number of such scales which would be required to make up the weight of an ounce troy. This number is 155,500, and yet these particles are large as compared with those usually found in quartz. These facts were given in a paper read before the San Francisco Microscopical Society.

It is estimated that the coin in circulation in Great Britain, loses by attrition, £20,000 in value per annum.

VOLATILITY OF GOLD.

Homberg was the first to notice that gold was volatile at a very high temperature. His experiments were made with a large lens, by the aid of which he readily volatilized gold leaf. If a slip of gold foil, or leaf, is placed between plates of glass, the ends being allowed to project, and a powerful current of electricity passed through it, the gold will disappear, while a purple stain will be left on the glass. This experiment was first made by Franklin.

Advantage is taken of the power of electricity to volatilize gold by spectroscopists, when they desire to examine the spectrum of that metal. Some years ago, in Calaveras County, an old furnace used in roasting pyrites, preparatory to its treatment by chlorination, was torn down, and the arch found to be coated with gold. A specimen is preserved in the museum of the University of California. This is a proof that gold is volatile at a comparatively low heat; it has long been known that it is volatile at a high temperature.

Some interesting experiments made by Mr. James Napier, assayer of the Mexican Mint, published in the Quarterly Journal of the Chemical Society, London, 1857, also show that gold is volatile at a low temperature. The same experiment was made a number of years ago at the old mint at San Francisco, when gold was discovered on the roof of that building. The experiments of Mr. Napier show that gold, when alloyed with copper, becomes volatile in proportion to the copper present, and to the degree of heat. In one experiment, gold was melted in a small clay cup, with a cupel inverted over it. On removing the covered cup from the fire the cupel was observed to show the characteristic purple stain of gold. A second experiment gave positive proof of the volatility of the precious metal. Observing fumes rising from a black lead melting pot, he placed a bell glass, wet with distilled water, over the pot, and within a few inches as it was being poured, the exposure only occupied one minute of time, on examining the under surface of the glass a million minute globules were observed. The bell glass was washed with water and again examined. The metallic powder was collected, cupelled, and a globule of gold obtained, weighing 4.25 grains.

In refining platinum by the process of St. Claire de Ville, gold, with other metals, is volatilized by the heat required to melt the platinum. This high heat is produced by the compound or oxyhydrogen blowpipe. In melting the natural platinum alloys, the foreign metals, such as copper, lead, iron, silver, and gold, are eliminated, and the platinum brought to a state of great purity, simply by raising the heat to a point at which the foreign metals are volatilized. Gold is seen to escape in fumes of a purple color.

The following extract is from the London Daily Telegraph of recent date:

That some chimneys are better worth sweeping than others was incontrovertibly proved a few days ago at Berlin, by the result of an experiment performed upon some soot with which the inside surface of an old flue, pulled down during the late alterations at the Royal Mint, was found to be thickly caked. This flue had served for many years as an outlet for the smoke given off by the furnaces in which the bullion undergoes fusion before its conversion into coinage, and it occurred to the architect superintending the repairs in question, that it might be worth while to analyze the soot lining the chimney through which fumes of boiling gold and silver had passed in such quantities. The liquefaction of the less precious metal requires a temperature of 1,000 degrees Celsius, while that of gold cannot be effected under 1,250 degrees. It is usual to bestrew the surface of these metals, when in a liquid state, with charcoal, in order to hinder evaporation. But at such a fierce heat as that above indicated, some evaporation is bound to take place, and its results were made manifest by the yield of four pounds' weight of pure gold, valued at something under 4,000 marks, obtained from the soot that was scraped off the inside of the melting-room chimney in question.

GILDING.

Gilding is the art of coating any required surface with a thin film of gold so perfectly that the surface so gilded shall have the appearance of being wholly gold.

The art of beating gold is very ancient. On the Thebian mummy cases, gold has been found nearly as thin as the gold leaf of the present day. After the destruction of Carthage, gold was so plentiful that ceilings of temples and palaces were gilded, and the luxurious tastes of the age were such that even the poorer classes used gold leaf to ornament the walls of their houses. Fire gilding is done by forming an amalgam of gold and mercury, rubbing the surface to be gilded with the amalgam, and driving off the mercury by heat. Silver is simply cleaned, rubbed with the amalgam, and heated. It may then be burnished; copper and brass, however, must first be wet with a solution of cyanide of potassium or proto-nitrate of mercury.

A gilding solution, much used in the arts, is prepared by adding two volumes of highly concentrated sulphuric ether to one of a saturated solution of ter-chloride of gold. The ethereal solution, which separates, must be decanted, drawn off with a syphon of glass, or by a separating funnel; the gilding solution so prepared must be preserved in a clean glass stoppered bottle. When applied to any surface with a soft camel's hair brush, the ether evaporates, leaving a coating of gold. This is to be burnished after the article has been heated.

If a piece of silk ribbon is moistened with a dilute solution of ter-chloride of gold, and exposed while still wet, to a current of hydrogen gas, the gold is reduced, and the ribbon becomes beautifully gilded. Leather is gilded by dusting the surface with powdered gum mastic; on this the gold leaf is laid and burnished. Porcelain is gilded by applying precipitated gold mixed with spirits of turpentine, to which a very small portion of oxide of bismuth has been added; the mixture is laid on with a soft brush. The method of precipitating gold will be described.

Gilding on the back of glass, which produces a brilliant surface like a mirror, is done by floating gold leaf on a solution of gelatin, in weak alcohol, laid on the perfectly cleaned glass with a camel's hair brush, which has been recently washed in distilled water. The solution must be laid on with a free hand. As the solution dries, the gold adheres to the glass and forms a lustrous surface, which may be greatly improved by applying a second coat of gold leaf in exactly the same manner. The solution must not be too strong, as the gilding will peel off in such a case. It is best to experiment on small pieces of glass until the right strength is obtained.

The solution is prepared as follows: Two parts, by measure, of distilled water and one part of pure alcohol, are shaken together in a clean, well-stoppered bottle; a small quantity, say five grammes, of pure gellatin, is placed in a clean vessel and covered with the alcoholic mixture; after standing for several hours in a perfectly clean place, a jelly is formed; the vessel is then to be placed over a spirit lamp and heated gently until the jelly is perfectly dissolved; five or six parts of the alcoholic mixture are then added, and the whole gently warmed; if the solution is not perfectly clear it must be filtered through paper.

To succeed with this gilding it is essential that the glass be made perfectly clean, and the solution entirely free from chemical and mechanical impurity, and the work must be done in a warm room. Gilding on ordinary gold lace is much thinner than gold leaf.

A large portion of the so-called gilded frames in common use are imitation. They are first covered with silver leaf, which is laid on in the same manner as gold leaf, and are then lacquered, which gives the silver the appearance of gold.

Oil gilding is done by applying to the surface of the work to be gilded a coating of gold size, which has the property of drying with a slight stickiness, called, technically, "tack." When this size is dry, gold leaf is laid on and rubbed gently with soft cotton. Gold size is a mixture of fat oil and the best quality of brown Japan. Fat oil is prepared by placing the best raw linseed oil (covered with a plate of glass, to keep out the impurities), in the direct rays of the sun for several weeks, until it becomes thick and viscid.

For gilding on glass, Pettijean's patent, the gold solution is prepared as follows: Dissolve one ounce of ter-chloride of gold in one quart of distilled water and filter the mixture; make separate solution of ten and a half drachms of citric acid in four times its weight of distilled water, to which add five and a half drachms of liquid ammonia, allow to cool, filter and pour into the solution of gold.

The glass to be gilded must be perfectly clean. To render it so, take a little of the gold solution and dip slightly into it a small clean piece of cotton wool and add to the moistened cotton wool a little dry putty powder—chloride of tin—and rub it carefully all over the surface of the glass. Then take a second piece of dry cotton and placing upon it a little of the dry putty powder, rub it all over the surface; after this dust the glass with a badger brush; lay the glass upon a suitable level table, heated to 150 degrees Farenheit, and pour upon it the gold solution until the whole surface is covered. The surface will retain about half a pint to each square foot. Leave the glass with the solution on it for about twenty minutes, during which time the glass will receive a coating of gold. Then, after pouring off the excess of the solution, wash the plate well by pouring over it sufficient warm distilled water. After which, set the plate on its edge to drain and dry. When perfectly dry, coat the plate with a quickly drying varnish or oil paint, laid on with a very soft brush. Certain precautions are to be observed in this process to insure success. Extreme care should be taken to keep all vessels clean, and the water used must not only be distilled, but free from mechanical impurities. It is well also to mix no more of the solution than is required for immediate use, as the gold will be deposited on the bottom of the vessels if allowed to stand, and the solution will be reduced in strength in proportion.

CHEMISTRY OF GOLD.

Ter-oxide of gold is a dark-colored powder, and its hydrate the same color, but of a lighter shade; both are reduced to metallic gold by the action of light and heat. Oxide of gold dissolves in hydrochloric acid, and partially, in sulphuric and nitric acids. All the salts of gold are yellow, and retain this characteristic color even when largely diluted. The salts are decomposed when heated—they have the property of reddening litmus paper even when free from other acids. Hydro-sulphuric acid precipitates all the gold from neutral or acid solutions. This precipitate is ter-sulphide of gold. The precipitate does not yield to any single acid, but dissolves readily in nitro-muriatic acid, and in the sulphides of the alkalies. Sulphide of ammonium also throws down gold from solution, as the ter-sulphide, which redissolves wholly in excess of the reagent, when an excess of sulphur is present.

Proto-sulphate of iron precipitates gold from solutions, in the state of finely divided metallic gold powder, at first black, but which becomes gold color and metallic, when dried and heated to redness. Gold so treated is chemically pure.

Ter-oxide of gold has the properties of an acid, and is called "auric acid." It may be prepared by digesting a solution of ter-chloride of gold with magnesia, washing the precipitate with water, and dissolving out the excess of magnesia with diluted nitric acid.

Hydrate-ter-oxide of gold forms salts with the alkalies, which are called by chemists "aurates." If finely divided gold be heated with sulphur in the presence of carbonate of potassium, a double sulphide of gold and potassium is formed, which is used in gilding porcelain. If highly concentrated sulphuric ether be added to an aqueous solution of ter-chloride of gold, the chloride will leave the water and take to the ether, which may be separated by decantation. This ethereal solution is used in gilding.

Metallic gold is insoluble in nitric, sulphuric, or hydrochloric acids, but dissolves in fluids evolving or containing chlorine. Nitro-hydrochloric acid is the usual solvent. The solution contains ter-chloride of gold; "Aqua regia," so called by the alchemists because gold (the king of the metals) was conquered by it. This solvent is a mechanical mixture of nitric and muriatic acids, generally in the proportion of one of the former to three or four of the latter. Gold is used as a reagent in analytical chemistry as a test for nitric acid—the substance to be tested being boiled with the muriatic acid and the gold leaf added. If nitric acid is present the gold will be dissolved. It is also a test for tin.

Proto-chloride of tin in solution, mixed with ter-chloride of gold also in solution, throws down, even if the solutions are dilute, a purple precipitate with a violet shade. This is one of the most delicate and characteristic tests for gold and tin. If the solutions are too dilute to give a precipitate, the violet color is still imparted to them. The precipitate is called Purple of Cassius, from a Dutch chemist, who lived at Leiden in the seventeenth century. Purple of Cassius may also be made by forming an alloy of gold, tin, and silver, and dissolving out the silver with nitric acid. To be able to do this, the latter metal must be in considerable excess. Gold Purple is used as a pigment. The composition of the precipitate is not well understood by chemists, but is regarded as a compound of binoxide of tin and protoxide of gold, mixed with protoxide and binoxide of tin and water. Ter-chloride of gold is prepared by dissolving gold—which may contain silver or copper—in aqua regia, evaporating to remove excess of acid, diluting again if necessary; filtering to remove chloride of silver, acidulating with muriatic acid, and precipitating the gold with solution of protosulphate of iron. The precipitate must be washed on a filter with distilled water, dried, redissolved in aqua regia, and evaporated on a water bath to crystallization. Chloride of gold is obtained by evaporating a solution of ter-chloride of gold to dryness, heating the powder on a sand bath at the temperature of melting tin, and stirring as long as chlorine is evolved.

Ammonia precipitates from concentrated solutions of gold an orange colored precipitate of aurate of ammonia called also "fulminating gold." It is a very dangerous substance—it can be dried at 212° F.—but the slightest friction causes it to explode with the greatest violence. A dreadful accident happened in the laboratory of Beaume—an assistant lost both of his eyes by the explosion of a vial of fulminating gold, caused by the friction of the glass stopper.

Gold may be separated from alloys of other metals, with the exception of tin, antimony, and platinum, by simply boiling with nitric acid, but the gold must not be present in a larger proportion than one fourth. Should the proportion be greater, silver or copper must be melted with the alloy, which must be granulated by pouring, while in a fluid state, into water. Upon being boiled in concentrated nitric acid, the other metals will be dissolved, leaving the gold as a metallic powder. Gold is also separated from alloys by means of strong sulphuric acid. The alloy is granulated, as above, and treated in a suitable vessel of platinum or cast iron. Two and a half parts, by weight, of 66° acid is added, and heat continued as long as sulphurous acid is evolved. By this treatment silver and copper become soluble sulphates, while the gold remains unchanged. The solution is poured off, and the gold again boiled with a fresh portion of acid, of 58° Beaume, and the whole allowed to remain for a time at rest. The gold settles from the solution; silver is precipitated by plates of copper; the copper replacing the silver, which, with the copper in the alloy, is crystallized out as sulphate of copper, or precipitated, as metallic copper, by plates of metallic iron. The gold still contains a small portion of silver, which is separated by a second boiling with strong sulphuric acid, after which it contains only .005 per cent. This process is not suitable for alloys containing more than twenty per cent of gold. If richer, the alloys must be remelted, with the addition of sufficient silver to reduce them to this standard.

GENERAL GEOLOGY.

Terrestrial matter can only be observed on the surface. We cannot penetrate a greater distance toward the center of the earth than about fifteen miles. To this extent only is the earth's crust broken, upheaved, and exposed. Thus our knowledge of the earth and its composition is in a double sense superficial. The tendency of certain physical forces is to wear away the asperities of the earth's surface, and to produce a smooth and unbroken sphere. Others break the crust, and reproduce inequalities. These opposing forces maintain, to a certain extent, an equilibrium. If the second were wanting, the world would in time become uninhabitable, for the globe would be a nucleus surrounded by concentric strata like the coats of an onion, covered by a stratum of water, above which the atmosphere would float. There could be no dry land, for the sea would cover all.

Matter is found to exist in nature in two forms, which chemists term elements and compounds. When matter can no longer be divided into component parts, each distinctly different, it is assumed to be an element, but it is by no means proven that the so-called elements are really such. On the contrary, it is the opinion of some of the most scientific chemists, that they may be greatly reduced in number, and that any or all of them may yet be proved to be compounds. Some go so far as to predict that all matter may yet be found to be one element, in different allotropic states or condition. The golden dream of the alchemist was based on this theory, and the same idea still finds a place in the deepest thoughts of the modern chemist.

At all temperatures elements react on each other and form compounds. Compounds again react and exchange elements in the most wonderful and intricate manner, until it is difficult to follow the changes. The study of the reactions which take place, and the laws which govern them, is the science of chemistry. The study of the phenomena of the universe, and the laws which govern the motions and relations of the heavenly bodies to each other, is astronomy. A knowledge of the earth as a unit is geology. At first thought, geology would seem to be a branch of astronomy, but it is in reality the concentration of all science.

There is nothing more unstable than the rocks, which are continually changing. A portion of the azoic rocks, which are named "primitive," and considered the oldest in the history of the world, became the sedimentary rocks of the cambrian, laurentian, silurian, devonian, jurassic, and cretaceous; animals and plants living in those remote periods having impressed their stamp upon them, which we now interpret as the record of their comparative ages. These secondary rocks were, in part, again denuded, and the earlier fossils being obliterated—a part, however, remaining intact—plants and animals of a more recent and advanced stage imparted to the now secondary and tertiary rocks a new character. Many transformations have varied them again and again; a portion in nearly every case remaining unchanged, and left as a sample, so to speak, by which the geologist is able to trace the history of many of them to the present day. The same matter in its present form contains the metals oxidized or combined with other elements, the gold and a few other metals remaining unchanged, except as to state of aggregation.

We owe our present existence to the changes going on in nature, including the death of animals and plants. There is only a limited supply of organic matter. If there had been no death the whole of the organic matter would, long before this, be wholly in use, and the great plan of nature be brought to a standstill. This is not only true as regards the animal and vegetable kingdoms, but the mineral must also be included. As one individual must die that others may live, so one set of rocks must give way to others. Hills must be raised, that there may be dry land. This depression of one part of the earth with a corresponding rise in some other goes on continuously, and will probably continue for countless ages to come.

If the generally accepted theory is true, that the earth is condensed from nebulous matter, there is reason to believe that metals having the greatest specific gravity exist in the largest quantities near the center of the earth. That they do exist in the eruptive rocks much disseminated must be admitted, and as the sedimentary rocks are built up from the ruins of the former, it is easy to account for the presence of the precious metals in them.

Sir Roderick Murchison has assumed that gold cannot be expected in considerable quantities above the palæozoic rocks. It has been observed by other geologists that in California gold is found in abundance in the jurassic and cretaceous formations. These more recent rocks are made up of the older ones, changed by the action of nature's laws, and gold being metallic and free, has gravitated to the position in which it is now found. The great mother vein, which is probably the source of all the gold in California, is so metamorphic in character that its geological age is still unknown; but there are evidences that it is much older than the formation in which gold is found. Had there been no eruptive rocks, gold would probably have been unknown to man.

Experience has shown that the soil of gold countries contains particles of gold which may be separated by washing. Beds of streams contain more gold after they enter the plains than before. Gold is found in certain localities in streams. In following them upward toward the mountains it is frequently found that the gold disappears. Many rivers afford no gold while they run in the hills, but it is found on bars below. Gold and iron are found associated in all localities, and it is a question if all pyrites will not afford at least a trace of gold with the same certainty that all lead contains more or less silver.

There is a remarkable instance at a mine in El Dorado County, California, in which small globules of gold are found on the surface of large crystals of pyrite. The gold seems to have been squeezed out of the crystals. Fine specimens of this singular association of minerals may be seen in the State museum. Humboldt has stated that in Guiana gold, like tin, is sometimes disseminated in an almost imperceptible manner in the granite rocks, without the ramification or interlacing of any small veins. At the Braidwood district, south of Sydney, New South Wales, there exists a variety of feldspathic granite, described by the Rev. Mr. Clarke as being permeated by small particles of gold; and Murchison has quoted a statement by Hoffman, that in Siberia gold is found in minute quantities disseminated through clay slate.

Gold has been observed native in the following minerals and rocks: Pyrite, chalcopyrite, galena, sphalerite, mispickel, tetradymite, native bismuth, stibnite, magnetite, hornstone, asbestus, tellurium, orpiment, hematite, barite, fluorite, siderite, chrysocolla, cuprite, granite, porphyry, and quartz. In California it is found at Moccasin Creek, Tuolumne County, in steatite; in the Manzanita Mine, Sulphur Creek, Colusa County, in cinnabar; in Mono County in calcite; in the Melones Mine, Tuolumne County, in sylvanite; in roscoelite at several localities near Colusa, El Dorado County; in galena, near Walker River; in pyrolusite at the Banghart Mine, Shasta County; in chalcedony in the Empire Mine, Grass Valley, Nevada County, and in asbestus near Georgetown, El Dorado County.

Dr. Percy thinks that gold is precipitated from an aqueous solution. Murchison holds that quartz is of volcanic or solfataric origin, and has all been in a gelatinous state, in which it included the gold mechanically. He gives as an example, the silicious sinter which rises in a fluid state from Hecla, and coagulates into quartz around the volcanic vents. Some of the igneous rocks of Europe are auriferous, as stated by Murchison. The oldest rocks are the most likely to contain gold in place, viz.: the azoic and the palæozoic. The general facts relating to the geological occurrence of gold are similar, without regard to geographical position.

LOCALITIES AND PRODUCTION OF GOLD.

The estimates of the production of gold which follow are compiled from various sources, and those selected which seem to be the most reliable. At the same time it must be said that writers differ so greatly that all statistics, except those published by government authority, must be taken as approximative only.

It has been shown that gold is found in nearly every part of the earth; but it is more abundant in some countries than in others.

EUROPE.

The gold mines of Spain have been worked for centuries; first by the Phœnicians and latterly by the Romans and the Moors. The gold is principally obtained by washing the sands of the Tagus Duero and lesser streams. Some rock masses were also worked, but recent investigations, made at extensive ancient workings, show but slight traces of gold. The deposits must have been wholly worked out, or the general yield extremely small. The product of gold at the present time is small, and is derived principally from the Rivers Sil and Sabor. The average annual yield has been estimated at $7,700. This is a poor return from mines once so celebrated. In the time of Christ very extensive and skillfully engineered works were carried on. Pliny describes the timbering of the mines, the shafts, adits, levels, etc.; how the miners smelted the ores, cupelled the gold, and used quicksilver to collect the finer particles very much as we do now.

In 1815, a gold mine at Adissa, in Portugal, yielded forty-one pounds weight of gold. There are no prominent mines in that country, and the product of gold is small.

There are no extensive mines of gold in France. The only known quartz ledge containing gold is "La Gardette," in the department of

Isère. It is from two to three feet wide, in gneiss. The Rhine has been worked for gold for centuries. The gold is found in the form of fine dust, associated with titaniferous iron. The scales are so small that from seventeen to twenty-two are required to weigh one millegram. M. Daubree estimated the yield in 1846 at $8,700; and he also estimated the result of the average day's labor at one and a half to two francs—twenty-eight to thirty-seven cents; although at times, under favorable circumstances, as much as fifteen francs—$2 79—were obtained. When this estimate was made, the gold placers in Siberia, containing as low as .000001 of gold, could not be treated with profit; but this was seven and a half times greater than the average from the sands of the Rhine. The washings from the sands of the River Ariége yielded, at the end of the fifteenth century, 100 pounds, troy, of gold annually.

Italy was a noted gold producing country in ancient times. At one period, according to Strabo, the mines of Illyria were so extensively worked that the over production caused a fall in the value of the precious metal to the extent of one third. Gold was also found at other localities in considerable quantities. In Pliny's time the product was so great that the Senate limited by law the number of slaves to be employed to 5,000, least the price of gold should fall.

In the Austrian Empire, Germany, the present yield is very small, but the mines and golden sands of the Rivers Aar, Rhine, Reuss, Danube, Moldau, Oder, and Weser have been worked from early ages. The total produce of gold in 1865 was 5,500 pounds troy.

Bohemia was also anciently noted for mines of gold. The mines of Eula yielded so largely in the year 734 that images of gold were cast from the bullion. The present total yield is estimated at $500. The gold mines of Hungaria and Transylvania have been worked continuously since the eighth century.

At Köningsberg gold is found in silver ores. Telluric ores are found in Transylvania, and at the mine of Kapink gold is associated with orpiment. The gold yield in 1865 was 5,395 pounds troy. In Tyrol and Salzburg the mines produce very low grade ores, which, however, are worked to a profit. In 1847 the average yield from the mines of Zell was only four parts in 1,000,000, or fifty-six grains to the ton. The annual yield was only sixty-five pounds troy.

Small quantities of gold have been produced by Switzerland and Holland, but the two countries have not contributed much to the world's supply of the precious metals.

GREAT BRITAIN.

Gold is occasionally found in the tin mines of Cornwall. In England some of the copper gossans contain more than traces of gold. It has also been found in very small quantities in Devonshire. The slate rocks of Wales have long been known to be auriferous, and a small amount has been extracted in modern times. According to the mining records the yield from 1861 to 1864, inclusive, was 11,623 ounces. At Gogofau, in Wales, there are ancient gold mines that were worked by the Romans. Traces of aqueducts, and even the troughs in which the gold was washed, may still be seen. In Merionetshire gold is still produced. In 1862, 5,299 ounces were extracted, and in 1863 the yield was 55,552 ounces. In 1864, 2,336 tons of quartz were crushed and 2,887 ounces of gold taken out.

Native gold has been found in Ireland, in grains from the finest dust to pieces three ounces in weight. In the County of Wicklow one piece of gold was found that weighed twenty-two ounces. In 1796 there was considerable excitement. The soil of the valley was washed for two years, and 1,000 ounces of gold were taken out before the placers were abandoned.

The lead hills of Scotland have produced a little gold. During the reign of James V 300 men were employed several Summers, and gold to the value of half a million of dollars was extracted. It is said that, at the wedding of James V, covered dishes, filled with coins of Scotch gold, were presented to the guests at dessert. At the present time gold is found in the beds of the streams after great floods.

RUSSIA.

The principal mines producing gold in Russia are on the western slope of the Ural Mountains. The mines in Asiatic Russia were discovered in 1743, and began to be worked in 1752. These mines are still productive. The placer mines of the Ural were opened in 1814. The richness of these mines will not compare with those of California and Australia; for, although some large masses have been found, the average ground worked would not pay at California prices for labor. From 1814 to 1860 the total yield was 1,500,725 pounds troy. The maximum was reached in 1847. The average yield is four to six parts in 1,000,000,=84 grains per ton, the value of which is $3 36. The yield of gold from the Urals in 1845 was 11,808 pounds troy, and the total product, from 1790 to 1830, was, according to Ure, 3,703,743 pounds sterling in value, which, reduced to dollars, is $17,926,116.

STATISTICS OF THE PRODUCTION OF GOLD FROM THE MINES OF RUSSIA.

The following tables are an abridged resume of the annual report given by the Administration of Mines. It will be noticed that these given vary much in completeness and detail, for the reason that the collection of statistics of the mining industries in Russia is made extremely difficult to a foreigner on account of the immense stretch of territory over which the mines are found dispersed (many are from 10,000 to 12,000 kilometers from the center of the empire), and because some of them, located at the further confines of Russia, are managed by individuals who are themselves ignorant of the Russian language:

Year.	Number of Mines.	Amount of Sand in Pounds.	Metal Extracted.			
			Pouds.	Livres.	Zolotniks.	Grains.
1867	878	968,423,325	1,649	23	30	29
1868	993	1,177,288,244	1,711	16	50	81
1869	1,129	1,054,570,392	2,006	25	72	8
1870	1,208	983,475,095	2,156	23	16	16
1871	978	1,081,518,424	2,399	37	78	8
1872	1,055	1,044,027,585	2,330	30	88	58
1873	1,018	954,648,764	2,024	29	30	79
1874	1,035	937,578,045	2,027	4	45	70
1875	1,092	1,007,293,492	1,995	29	44	37
1876	1,130	1,022,543,362	2,054	3	63	36

This given in troy ounces would be:

Year.	Troy Weight.	Values at $20.67.18 per Ounce.
1867	868,740.800076	$17,958,436
1868	901,303.289056	18,631,561
1869	1,056,784.285844	21,845,633
1870	1,135,746.730092	23,477,929
1871	1,263,913.686500	26,127,371
1872	1,227,484.611544	25,374,316
1873	1,066,310.886884	22,042,565
1874	1,067,563.697872	22,068,463
1875	1,051,040.099588	21,726,891
1876	1,081,772.294012	22,362,181
Total	10,720,660.381468	$221,615,346

The fluctuations in the production of gold by the different gold departments of Russia during five years, are shown in the following table:

GOLD PRODUCT, IN TROY OUNCES.

	1872.	1873.	1874.	1875.	1876.
State Department	68,463.55	58,457.34	47,397.84	36,864.99	33,178.49
Imperial Department	86,896.05	83,209.55	85,842.76	83,736.35	80,576.34
Private enterprises in Eastern Siberia	825,249.14	709,387.74	733,086.67	731,613.29	753,625.73
Western Siberia	92,689.12	75,836.55	72,676.70	62,197.13	63,197.13
Ural Mountains	149,039.89	137,980.39	126,920.90	132,713.97	150,619.82
Finland	1,579.93	1,053.29	526.64	526.64	263.32

Geographically, the gold production in Russia, for the year 1876, is divided among the Governments and Territories as follows:

From	Troy Ounces.	From	Troy Ounces.
Iacoutsk	330,481.47	Tomsk	56,508.76
Jenneseisk and Irkoutsk	203,231.43	Littoral	6,504.04
Transbaikal	123,168.57	Sémipalatinsk	6,148.55
Perm	92,978.77	Akmolinsk	487.14
Amour	90,411.39	Uleaborg	302.82
Ovenburg	57,706.88		

The grants (or privileges) for working gold mines taken up in Russia in 1874, comprised 2,514,495 "sagénes" in length, being 5,028 "verstes." Of this number the grants in Eastern Siberia amounted to 1,464,430 "sagénes;" those in Western Siberia, 516,096 "sagénes," and those in the Ural Mountains, 53,975 "sagénes."

Since 1753, the year of the commencement of the production of gold in Russia, up to 1876, inclusive, there has been produced in Russia 67,132 pouds 33 livres of gold—35,355,013.56 troy ounces.

The extraordinary falling off in the market price, and the high rate of exchange on the one side, as well as the abolition of the proportionate duty upon gold, and the passage of a peremptory tax on the gold mines of the State department, particularly the latter, show during the last year the immense advantages enjoyed by the grantees. The production of gold rose in 1877 to 2,430 pouds (1,279,741.81 ounces troy), valued at 40,000,000 roubles.

To appreciate these figures more fully it will be noted that the production of gold of the State department mines only amounts to 6,846.36 ounces, that is to say 26,332.14 ounces less than in 1876; that of the mines of the cabinet of the Emperor 74,783.62 ounces, and the balance of 1,198,112.19 ounces was furnished by the mines worked by private enterprises.

These last produced in 1877 230,142.87 ounces more than in 1876. The production of these private enterprises was divided as follows: Eastern Siberia, 944,270.40 ounces; Western Siberia, 67,936.86 ounces; Ural Mountains, 185,904.88 ounces.

It is desirable to note also that the production of gold has increased to more advantage this year in Russia, because these benefits have incited the grantees to an increase in their running operations, which increase is so great that, according to reports from Eastern Siberia, it is hardly possible to procure workmen or supplies when needed.

RUSSIAN GOLD PRODUCT.

[Extract from "Mining Industry in Russia from 1860 to 1877, by A. Koppen, mining engineer." In *Russiische Revue,* for 1880. Translated for the *Mining Record* of April 15, 1882, by H. L. Koopman.]

Gold production in Russia was started by the government in 1745. In that year the first gold and silver were obtained on the Schlangenberg in the Altai, and sent to St. Petersburg. In the same year, 1745, gold was also first found in the Woitzkisch mine (Govt. Archangel). The year 1745 was finally made remarkable in the history of Russian mining by a third discovery, which laid the foundation for all the later gold wealth of Russia. This was the discovery of the gold mine of Beresowsk, in the neighborhood of Jekaterinenburg, which sent its first gold to St. Petersburg in 1745, namely: sixteen pounds, fifty-nine solotink and fifty-four doli of bullion.

The most important effect upon the gold production was wrought by the abandonment of the Ukas, May 28, 1812, in consequence of which private citizens were permitted to take up gold and silver mining on their own account. The working of the gold washings, or the so-called gold dust, was first granted to citizens in the year 1819, and then only to the owners of mining or smelting works. Newjansk on the Ural is where the first gold was washed by private enterprise, and until the year 1828 private gold production confined itself to the district of the Ural mountain range. Later, gold production began to extend generally, reaching further and further eastward into Siberia, and now gold is obtained in all West and East Siberia, in the governments of Perm and Orenburg, and in the Kurgis Steppes. There the government, until very lately, had gold washings on the Ural. The government of His Majesty the Tsar now works the gold in the Altai and Nertschinsk mountain district, and, finally, private citizens in all the above mentioned regions are engaged in gold production.

From the crown and private washings was obtained in 1814–1859, in gold alloy: *

Years.	Pud. lbs.	Years.	Pud. lbs.
1814	16.3½	1837	493.5
1815	14.9	1838	495.32¼
1816	15.32	1839	557.39½
1817	18.7	1840	646.16
1818	16.26½	1841	909.3
1819	14.9	1842	1,241.11¾
1820	19.24¾	1843	1,279.26¾
1821	27.28½	1844	1,307.8
1822	53.32	1845	1,611.26½
1823	105.26½	1846	1,757.8
1824	205.33½	1847	1,684.28¾
1825	237.17	1848	1,588.5
1826	231.10	1849	1,453.32½
1827	281.33¼	1850	1,474.2¾
1828	290.34	1851	1,366.30½
1829	289.27½	1852	1,363.16½
1830	360.8	1853	1,596.26¾
1831	367.33¾	1854	1,649.13¾
1832	378.27½	1855	1,655.19½
1833	375.5½	1856	1,733.23¾
1834	386.8½	1857	1,687.24
1835	398.30½	1858	1,541.33¾
1836	442.22¼	1859	

* The Russian "poud" equals 526.642720 troy ounces, and the pound equals 13.166068 troy ounces. The pound avoirdupois equals 14.583 troy ounces.

Since the year 1860, which I have taken for the beginning of my review, there has been obtained in gold dust from the washings belonging to the crown, to the cabinet of His Majesty the Tsar, and to citizens:

Years.	Pud. lbs.	Years.	Pud. lbs.
1860	1,491.17½	1869	2,028.31½
1861	1,456.4½	1870	2,162.27½
1862	1,460.29	1871	2,400.36¾
1863	1,459.19	1872	2,308.12
1864	1,397.37	1873	2,024.38½
1865	1,576.7¾	1874	2,028.4½
1866	1,659.19¼	1875	1,995.29¼
1867	1,649.24½	1876	2,094.3½
1868	1,711.16½	1877	2,502.6½

From the above figures it may be seen that before 1860, the output of gold was the richest in the years 1847 and 1857, amounting to more than 1,700 pud.

From the year 1857 began a falling off in the gold yield, which amounted in 1860 to only 1,491 pud, and in 1864 even fell below 1,400 pud. In the seven years following, gold production made a swift advance and rose almost 1,000 pud; in the next four years it sank again to below 2,000 pud, and not till the last two years, 1876 and 1877, was a rapid rise again noticeable, when the height of 2,500 pud was reached.

Scanning the above tables more closely, we note at once that the recorded shrinkage in the total gold yield of Russia depended altogether upon the output of private washings. The fall in gold production at that time was chiefly due to weather conditions; that is, either to drought, which caused a lack of water at the washings, or to excessive rain, in consequence of which the rivers overflowed, preventing a rich yield from the gold-bearing sands; and finally, not seldom, both these obstructions falling in the course of a Summer—first drought and then continued rain—brought work at the gold washings to a standstill. Moreover, the following must be accepted as causes which influenced the lessening of the gold yield: the utter exhaustion, not only of separate rich washings, but also of the whole district, and the failure of many owners.

Temporary rises in the gold yield were brought about by chance discoveries of exceedingly rich gold diggings. The sudden rise in figure of the gold dust obtained in the last two years depends partly upon the increase of the percentage of gold duty, established in 1876, though chiefly upon the high value of our coin, since, as is known, for all gold delivered at the mint account was made in half imperials, these being reckoned at their face value.

According to districts, the gold obtained in Russia is divided as follows:

GOLD YIELD IN RUSSIA (IN PUD.)

Year.	Ural.		West Siberia.		East Siberia.		Finland	Total.
	Crown Washings.	Private Washings.	Altai Mt. District.	Private Washings.	Nertschinsk Mt. Dist.	Private Washings.	Private.	
1860	114¾	214½	33¼	38½	75¾	1,014¾	--------	1,491½
1862	96¾	196½	20	42¼	83¾	1,021¼	--------	1,460¾
1867	91¼	302½	23¾	86¾	142¼	1,003¼	--------	1,649½
1872	129¾	283	13½	176	153¼	1,519¼	3¼	2,308¼
1877	13	392½	11¾	130½	142¾	1,811	½	2,502

From this table it may be seen that:

First.—At the crown washings on the Ural, the gold production had well nigh stopped. In the year 1876, only sixty-three pud of gold were obtained here, and in the year after barely thirteen pud. This sudden change arose from the fact that in the year 1876, the crown washings of Miask were given over to private citizens.

Second.—The figures of the gold yield at the Ural private washings, which made 286 pud in 1876, rise at once in 1877 to 392½ pud, through the addition of the yield from the washings of Miask.

Third.—In the Altai District the gold product shows a continual falling off, and hardly amounts to twelve pud in 1877; that is, it has become reduced to one third in the last eighteen years.

Fourth.—Quite the contrary do we find in the gold washings of citizens in West Siberia, where the gold yield slowly but steadily rises, and has increased three and a half times in the course of eighteen years.

Fifth.—In the Nertschinsk Mountain District, the gold yield doubled from 1860 to 1872, and in the last year amounted to 153 pud. Since 1872 it has again fallen a little.

Sixth.—The private washings of East Siberia furnish the greatest amount of gold and entirely govern the rise in the total gold yield of Russia. While, in the last eighteen years, the washings worked by private citizens in East Siberia have increased their production by about 800 pud, all the remaining gold washings were only in a condition to raise their output of gold to 200 pud. From 1860 to 1877, the gold yield of the private washings in East Siberia increased about eighty per cent.

Seventh.—Finally, it is to be noticed that gold production began in Finland in 1870, and reached its highest point in the year following, when the figures of the gold here obtained made only three pud eighteen pounds. From the year 1872, the gold yield of Finland gradually sinks, and in 1877 comes to less than twenty pounds.

If we consider the year 1877, we see that the percentage of gold yield is shared by the different districts, as follows: The private washings of East Siberia furnished 72.4 per cent. of the total yield; the private washings of the Ural 15.66 per cent.; the Nertschinsk Mountain District 5.7 per cent.; the private washings of West Siberia 5.2 per cent.; the Ural crown washings 0.52 per cent., and finally the Altai Mountain District 0.43 per cent.

As the private washings of East Siberia furnish at most three quarters of all the gold obtained in Russia, we give in the table a statement of the yield in the different districts of that territory:

GOLD YIELD IN EASTERN SIBERIA, IN POUDS.

Year.	Government of Jenisseisk.				Kansk, Nisbue, and Udinsk Districts, Government of Irkutsk	Transbaikal.				Olekninsk District, Government of Jakutsk	Amur Territory	Coast Region
	Jenisseisk District.		Atschinsk District	Minussinsk District		Werchue Vdinsk District	Bargusinsk District	Nerchinsk District	Wercho-Lensk District			
	Northern part	Southern part										
1860	425¼	188¾	20	48¾	31¼	15½	85½	------	------	199½	------	------
1862	376½	181¾	15	49½	29½	16	131¾	------	------	217	------	------
1867	324¾	119	21	31¾	26½	13	94¼	105¾	------	267	------	------
1872	246½	162¾	15¾	29½	12¾	12½	60½	177	1	630¾	196	4½
1877	158½	167¼	20	37¼	37¾	13¼	27¼	227¾	------	928	172	12¾

In the district of Jenisseisk, which was once distinguished for its gold wealth, the yield began to lessen in 1850, and from 1860 to 1877 it diminished during the whole period. Especially strong is this falling off in the northern part of the district, which furnished in 1860 425 pouds, about 42 per cent. of all the gold obtained in the whole of East Siberia. In the year 1877 only 158½ pouds were obtained here, that is, not more than 8.75 per cent. of the total gold yield of East Siberia.

In other districts belonging to the basin of the Jenisei, such as Atschinsk, Minnerssinsk, and Kansk, in the Government of Jenisseisk, and Nishere Udinsk in the Government of Irkutsk, the mass of gold produced is, in the main, not large, and has suffered no special change during the last eighteen years.

As concerns the Transbaikal, it is plain that in the districts of Werchue, Udinsk, and Bargusinsk the gold yield continually diminishes. In the latter of these two districts the total gold product amounted in 1877 to not more than 27¼ pouds, which is about one fifth of that yielded in the year 1862 (131¾ pouds).

In the district of Nertchinsk, private citizens were first permitted to work the gold washings in the year 1864, and here in 1865 began a gold yield (32 pouds) which, very swiftly rising, reached the sum of 227¾ pouds in the year 1877; that is, increased sevenfold in twelve years.

In the district of Wercho-Lensk, gold production has been in operation since the year 1867, and in an extremely narrow compass, goes on without interruption.

Undeniably the richest and most productive gold washings are found in the basin of the Lena and its tributaries, the Witem and the Olekma in the Olekminsk district, in the Government of Jakutsk. In the year 1860 the amount of gold produced in this district came to less than 200 pouds; in 1877, 928 pouds were obtained here; that is, the yield increased more than four and a half times.

In the Amur district, gold production was granted to citizens in the year 1866, but the yield began in 1868 with the sum of fifty pouds. In the next year, 1869, the yield was doubled, and from that rises generally, and in the year 1872 reaches the figure of 196 pouds. In the years following the yield suffers but little shrinkage, and varies between 150 pouds (1874) and 173 pouds (1875).

In the coast region of East Siberia gold production began in 1872, continues with interruption and makes but slow development, which must be ascribed to the lack of skilled labor and the dearth of necessities.

Finally, it must be observed that in the year 1877 gold production began again in the districts of Krassnojarsk and Irkutsk, in the Government of Jenisseisk, eight pouds twenty-four pounds of gold being yielded by the former, and seven pounds by the latter.

Year.	Pouds.	Pounds.
Eighteen hundred and seventy-four	2,028	4
Eighteen hundred and seventy-five	1,995	29
Eighteen hundred and seventy-six	2,054	4
Eighteen hundred and seventy-seven	2,502	7
Eighteen hundred and seventy-eight	2,572	4
Eighteen hundred and seventy-nine	2,631	30
Annual average	2,297	10

These figures, said to be derived from the report of the Sub-Director of Russian mines, were published in the St. Petersburg Herald.

In Eastern Siberia, the production of gold diminished on account of the dearness of provisions, the advance of wages, the cost of transportation, the sanding-up of several districts, and the drought in Nertschink and Tschitinsk, on the eastern slope of the Jablonoi Mountains. In Western Siberia, the production slightly increased, and in the Oural it increased considerably, on account of the arrival of a large number of good workmen at the mines of Miassk, and the discovery of several deposits of rich auriferous sands in the datsche of Sialkovsko-Demarinsk, and in the new Orenburg line in the circle of Orsk. At the end of 1879, the number of gold mines belonging to private individuals rose to 1,522 in Eastern Siberia, to 291 in Western Siberia, and to 1,233 in the Oural.

ASIA.

Southern Asia is rich in gold; the Himalayan chain has, from ancient times, yielded large quantities. Some writers are of the opinion that the Ophir of Solomon was in that country. Gold is still an article of commerce in India. The sands of the Burampooter are estimated to produce from 30,000 to 40,000 ounces annually. Five hundred years before Christ gold was very abundant in Little Thibet and Cabul, Afghanistan. Gold is found in the sands of many small streams in Western Thibet, north of the Kailas Mountains, in quartz veins, running through a crumbling red granite.

Thibet is thought to be still a rich gold locality, but it has never been thoroughly prospected. The annual product is estimated at 833 pounds troy. Burmah is also a gold country, but there are no reliable statistics of quantities produced; the annual yield is thought to be 2,000 pounds troy.

The Siberian gold fields extend into China, where mines have been worked at various times. The Chinese Government does not now permit the mines to be worked, for the reason that it would render the inhabitants discontented, and that the agricultural interests would be neglected, which is not an unwise view, when all things are taken into consideration.

Japan, for many years, was a gold-producing country. The Dutch absorbed so much silver in their dealings with that country, that the Japanese Government was compelled to substitute gold for that metal as a circulating medium, and for a long period gold was of a less value, as compared with silver, than in other countries. At the time of the treaty with the United States, the relative value of gold to silver was as one to three and seven tenths. The first discovery of gold in Japan was in the year 758, before which gold was imported from China. The amount exported from Nagasaki, from 1611 to 1706, was $68,118,600 in value.

Gold is found in Japan in ores of copper. The government at one time, finding that gold was being largely withdrawn from the country by foreigners, forbid its exportation. The total yield of gold in Japan and China is unknown to Europeans.

Several of the East India islands, as Timor, Formosa, Java, Borneo, Sumatra, Celebes, and the Philippines, yield gold, and that metal will probably be found on others not at the present time known to be auriferous. In Borneo, gold is washed by Chinamen in alluvial soil at the foot of a chain of volcanic mountains. The production of this island is estimated at 5,000,000 dollars yearly.

AFRICA.

Nearly all the gold from Africa is in the form of very fine dust; negroes offer it for sale in quills of the ostrich. The principal mines are in Kordofan, in the central part of the continent. These mines were known to the ancients. Herodotus relates that the King of that country exhibited the State prisoners to the Embassadors in chains of gold. Another locality has derived its name from its trade in gold dust, and is known as the "Gold Coast." It is a portion of Guinea, and extends along the coast from the River Volta to Cape Lahu. There are no mines proper, but gold is washed from the soil of the plains. On the eastern coast, opposite Madagascar, gold has also been found in considerable quantities, and this locality has been supposed by some writers to have been the Ophir of Solomon. Bambouk, south of the Senegal River, Western Africa, is another well known and productive locality.

Africa was probably the gold center of the ancients. Gold was abundant in ancient Egypt, judging from the amount of that metal found on mummies and in tombs. African gold from Bambouk is 22.5 carats fine, and that from Morocco 23 carats.

MEXICO.

While the principal mines of Mexico are silver mines, nearly all of them produce gold in combination with the other ores, as the Comstock mines have done since their discovery. There are, however, mines which produce gold almost exclusively. Mines of this character are found in the State of Oaxaca. It is said that the Spaniards found a placer in Sonora with gold only, which was eighteen inches deep and forty-two miles in extent. They took out very large quantities of gold by picking out the lumps without washing. One piece weighed 132 ounces, and is preserved in the Royal Museum at Madrid. The estimated product of gold by Mexico, from 1790 to 1830, is £6,436,453.

NEW GRANADA.

New Granada has mines both of gold and silver. Near Pamplona, single laborers have collected one thousand dollars worth of gold in a single day's labor. Both placer and quartz mines are worked. The total yield from 1804 to 1848 is estimated at $196,954,319. The mining localities are very unhealthy, and it has been the experience of English capitalists, who have been engaged in working the mines, that the results were not satisfactory. In the placers of Choco, gold is associated with platinum, hyacinth, zircon, and titanic iron, which is the case in the placers of California. It is also worthy of remark that silicified trees, so common in the hydraulic mines of California, occur in similar formations in New Granada. The gold of Antioquea is twenty carats fine, and that of Choco twenty-one carats; the largest nugget found weighed twenty-seven and a half pounds avoirdupois. The gold from Giron is the finest in America—being twenty-three and three fourths fine.

BOLIVIA.

The annual yield of gold from Bolivia is estimated at 1,600 pounds troy.

PARAGUAY.

It is said that a portion of a mountain fell down many years ago in Paraguay, and that in the fallen portion pieces of gold were found which weighed from two to fifty pounds each.

CHILI.

Considerable gold has been produced by Chili, but there are no reliable statistics as to total quantity. Humboldt estimated the yield in 1800 at 7,500 pounds troy. From 1790 to 1830 the production of gold has been estimated at £2,768,488.

BUENOS AYRES.

The yield of gold from this country has been estimated as follows: From 1790 to 1830, £4,024,895, but there seem to be no reliable statistics of the production since that date.

BRAZIL.

Brazil has long been noted for its gold mines. The placer gold has principally been taken from Minas Geraes, which are not yet exhausted. The largest yield from this country was in the middle of the eighteenth century. From 1752 to 1761, the amount produced annually was from 17,000 to 21,500 pounds troy. The most important gold mines, other than placer, are those of Morro Velho, the property of the St. John Del Rey company, which has been working what in California would be termed rebellious ores ever since 1830, with great success. A full set of the reports of this company have been placed in the library of the State Mining Bureau. Another English company, called the Rossa Grande Gold Mining Company, was founded in 1864. Nearly all the gold now produced in Brazil is extracted at the works of the great English companies.

PERU.

Peru is a noted gold country. Nearly all the rivers are auriferous, and the Peruvian Andes are rich in mines of gold and silver. At the present time the mines of gold are almost wholly worked by the Indians. Yet the annual yield is estimated at 2,400 pounds troy. Under the control of an enterprising race, like the English or the Americans, the country could be made to add materially to the gold of the world. The valley of the Chuquiaguillo River was anciently worked. The principal gold found in the country, and absorbed by the Spanish at the time of the conquest, was supposed to have been derived from that source.

CANADA.

Gold is found in Canada, but the amount produced is small, and the quantity that can be extracted per man (which is the true test of the value of a gold region) is less than that of other American gold fields. The gold quartz is far below the average of California, Idaho, Colorado, and other States of the American Union. Canadian gold discoveries were made known in 1847, but it is stated, in the history of the country, that a French-Canadian named Léry had found specimens long before. In 1851–2, fifteen men collected eighty ounces, including one nugget weighing two ounces, from the Chaudeire River. At Gilbert Diggings, William Abbot took out $1,750 worth of gold, and stated that he had seen nuggets worth $300.

BRITISH COLUMBIA.

Gold was first discovered in British Columbia in 1856. Mr. Douglas, Governor of Vancouver's Island, reported to the General Government the discovery of gold in British territory, near the forty-ninth degree of latitude. In 1858, the Fraser River excitement took place. Since that time numerous gold localities have been discovered and worked in British Columbia. Gold exported from Cariboo in 1864 was $250,000. In 1865, it was nearly $1,000,000.

NOVA SCOTIA.

Gold was first discovered in 1860, at the head of the Tangier River. In 1861, a man drinking at a small stream a mile east of the same river, saw a gold nugget among the pebbles, and, instituting a careful search, found considerable gold in the bed of the stream. This remarkable discovery led to the opening of gold quartz veins, and the production from the years 1862 and 1865, inclusive, of 60,708 ounces of bullion. The report of the Gold Commissioners for the year ending September 30, 1865, states that the result of a day's labor in the gold mines in the province, from its discovery to the date of the report, has steadily increased, at which time it averaged $2 13 to the man. The production of gold mines in 1865 has been stated to be 24,867 ounces.

UNITED STATES.

The United States have become one of the great gold-producing countries of the world. The precious metal is found on the eastern as well as the western part of the continent. Long before California was discovered, extensive mines of gold were worked in the southeastern States of the Union. The Southern States in which gold has been found are North and South Carolina, Virginia, Tennessee, Alabama, and Georgia. The first notice of the discovery of gold was about the beginning of the present century. In 1799, a young man named Reed is said to have found a nugget of gold in Cabarrus

County, North Carolina, which was the size of a small smoothing iron. This he retained in his possession for several years, and then, not suspecting its value, sold it for about fourteen shillings. Shortly after, gold was discovered in Montgomery County, where washings on a small scale were conducted, and, notwithstanding only the sands of several streams were washed, nuggets of gold of a large size were found. One weighed thirty-eight pounds, and a number of others were washed out weighing from four to sixteen pounds.

The first United States gold was coined in the year 1825. From 1804 to 1827 all the gold produced in the United States came from North Carolina, the amount of which was $110,000. In 1829 Virginia produced $2,500, and South Carolina $3,500. The first mint deposit from Georgia was made in 1830, and was valued at $212,000. The first quartz ledge ever worked in the United States was opened in North Carolina in 1825, from which 625 ounces of gold were extracted. When gold was discovered in California the experience made in the gold mines of the Southern States was of the greatest value to the California miners; and it is claimed that the pan, rocker, and long tom were introduced from the older American mines, and in some cases worked by those who had learned to use them at the South. Stock gambling appeared almost with the discovery of these mines; and Professor Silliman, who visited them in the year 1836, warned the nation of the evils likely to result from the excitement, already begun, in words that would not be inappropriate at the present time. He wrote as follows:

In my judgment nothing could be more inauspicious to the mining interest and the welfare of the country than a spirit of speculation in these concerns. In an excited state of the public mind it is rare that facts are correctly reported or correctly viewed. The speculator, who buys merely that he may sell again, is too frequently ignorant of the facts, and reckless of the consequences in regard to those who may succeed him in his obligations. Flattering gains from sales of stocks are reported from day to day; the property rapidly changes hands; the public mind, being morbidly excited, is of course blinded, and, at no distant period, accumulated ruin falls heavily on the last of the train.

At the time of the discovery of gold in California attention was drawn from the mines of the Southern States, but latterly they are beginning to be worked again, and with better success than before, owing, probably, to the experience of California, and of the Western States generally. At the Paris Exposition of 1878 a fine nugget of gold from Georgia was placed on exhibition in the American section. The following newspaper extract, quoted from an unknown source, alludes to the renewed activity in the old mines of the South:

In the old gold districts of Virginia, the scene of the battles between Lee and his Federal opponents, there is a return to the gold searching of other days. More than two million dollars were obtained in the past year from Culpepper, Louisa, Goochland, Orange, Spottsylvania, Fluvanna, Buckingham, Prince Edward, and other neighboring counties of Virginia, and since the rebellion hundreds of former Confederate soldiers have been engaged washing the gold deposits. It is stated that about two thousand of such miners are now at work in Louisa and Goochland Counties, and that the average is two pennyweights a day to each miner.

The following is an extract from an unknown newspaper:

It is estimated that three hundred million dollars in gold was transferred from the United States to Europe during the rebellion. The condition of the national treasury, which contains more bullion than the national treasury of France or England, is a conclusive proof that the drain has ceased, and that the United States is not only the greatest producer of gold in the world, but contains more of it than any other country.

GOLD PRODUCTION OF CALIFORNIA.

In attempting to collate from available sources the total gold yield of the State of California, the compiler is struck with the remarkable disparity in the estimates of various authors, and is led to conclude that very little dependence is to be placed upon them, that they are the merest guess work and wholly unreliable. It will be noticed that the annual production is generally given in even millions of dollars, which is self evidently incorrect, for it is next to impossible that for three years in succession the product should be exactly fifty-five millions of dollars, as shown in the table published by J. A. Phillips.

That the reader may draw his own conclusions various estimates are placed side by side and the authorities given.

TABLE

Of the Gold Product of California from 1848 to 1866, Inclusive; Compiled by J. A. Phillips, and Published in his Metallurgy of Gold and Silver, Folio 66.

Year.	Amount.	Year.	Amount.
1848	$10,000,000	1858	$50,000,000
1849	40,000,000	1859	50,000,000
1850	50,000,000	1860	45,000,000
1851	55,000,000	1861	40,000,000
1852	60,000,000	1862	34,700,000
1853	65,000,000	1863	30,000,000
1854	60,000,000	1864	36,600,000
1855	55,000,000	1865	28,500,000
1856	55,000,000	1866	26,500,000
1857	55,000,000		
		Total	$836,300,000

TABLE

Of the Production of Gold in California, Compiled by Eaton S. Drone, and Published in the American Encyclopedia, Vol. VIII and Folio 81. To 1865 the Figures are from Phillips.

Year.	Amount.	Year.	Amount.
1848	$10,000,000	1861	$40,000,000
1849	40,000,000	1862	34,700,000
1850	50,000,000	1863	30,000,000
1851	55,000,000	1864	26,600,000
1852	60,000,000	1865	28,500,000
1853	65,000,000	1866	25,500,000
1854	60,000,000	1867	25,000,000
1855	55,000,000	1868	22,000,000
1856	55,000,000	1869	22,500,000
1857	55,000,000	1870	25,000,000
1858	50,000,000	1871	20,000,000
1859	50,000,000	1872	19,000,000
1860	45,000,000	1873	17,000,000
		Total	$985,800,000

TABLE

Of the Production of Gold for the Pacific Coast, published in the Annual Edition of the San Francisco Journal of Commerce, January 22, 1879.

Year.	Amount.	Year.	Amount.
1848	$5,000,000	1864	$55,967,605
1849	23,000,000	1865	57,496,800
1850	59,000,000	1866	62,000,000
1851	60,000,000	1867	59,000,000
1852	59,000,000	1868	51,000,000
1853	68,000,000	1869	47,000,000
1854	64,000,000	1870	48,000,000
1855	58,000,000	1871	42,357,000
1856	63,000,000	1872	42,688,103
1857	64,000,000	1873	41,500,000
1858	59,000,000	1874	49,150,000
1859	59,000,000	1875	50,750,000
1860	52,000,000	1876	53,100,000
1861	50,000,000	1877	50,700,000
1862	52,000,000	1878	46,370,000
1863	57,000,000		
		Total	$1,609,079,500

TABLE

Of the Gold Product of the Pacific States for the last Twelve Years; the Net Product of the States and Territories West of the Missouri River, after deducting the product of British Columbia and the West Coast of Mexico—by John Valentine, General Superintendent of Wells, Fargo & Co.'s Express.

Year.	Amount.	Year.	Amount.
1870	$33,750,000	1876	$42,886,935
1871	34,398,000	1877	44,880,223
1872	38,177,395	1878	37,576,030
1873	39,206,558	1879	31,470,262
1874	38,466,488	1880	32,559,067
1875	39,968,194	1881	30,653,959

TABLE

Of the Production of Gold from California, from Ures' Dictionary Supplement, folio 572.

Year.	Sterling.	U. S. Currency.
1848	£11,700	$56,628
1849	1,600,000	7,744,000
1850	5,000,000	24,200,000
1851	8,250,000	39,930,000
1852	11,700,000	56,628,000
1853	12,500,000	60,500,000
1854	14,100,000	68,244,000
1855	13,400,000	64,856,000
1856	14,000,000	67,760,000
1857	13,110,000	63,452,400
Totals	£93,671,700	$453,371,028

The following from the circular of Hussey & Co., San Francisco, July 30, 1852, and quoted by Ure, shows the amount of gold from California deposited in the mints of the United States during the first four years after the discovery of the precious metal:

1848	$44,177
1849	6,147,509
1850	36,074,062
1851	55,938,232
Total	$98,203,980

Sir J. F. W. Herschel wrote a letter, dated Royal Mint, London, February 7, 1852, in which he says that it is believed that California gold to the value of £18,000,000 had been found during each of the last two years (1850 and 1851), and that prior to the discovery of gold in that country the whole annual product of the world was supposed to be only one fifth of that amount.

In 1851, Mr. Birkmyre published a statement in the London Times to the effect that the product of California to that date was £17,339,544, and Mr. Scheer estimated the yield to January 10, 1851, at £62,000,000.

The following table is from the San Francisco Alta California of December 23, 1881. It is interesting, as showing that a known quantity of gold dust is exported from the State. What the unknown quantity has been can never be determined, and this fact is further evidence of the utter unreliability of estimates made of the total production of the State.

TREASURE SHIPMENTS.

In 1881 the following shipments of treasure were made to China, including Hongkong:

Months.	Silver Bars.	Gold Dust.	Gold Coin.	Mex'n Dol'rs.	Totals.
January		$500	$4,820	$70,244	$75,564
February	$330,000	300	15,610	292,389	*638,319
March			5,735	57,230	62,965
April	467,630	170	17,985	285,505	771,290
May	126,800	500	15,531	266,587	409,418
June	1,500	20	23,343	121,417	146,280
July	249,590	1,904	28,787	123,409	403,690
August		3,551	26,852	146,239	176,642
September		13,100	35,200	154,092	202,392
October		3,140	56,482	279,236	338,858
November	56,987	6,380	67,805	148,775	279,947
December		4,125	70,107	173,940	248,172
Totals	$1,232,507	$33,690	$368,257	$2,119,063	$3,753,537
1880	$1,156,279	$35,224	$330,901	$2,154,182	†$3,677,586

* Includes twenty trade dollars. † Includes 1,000 trade dollars.

A gilded cube has been placed in the Museum of the State Mining Bureau, which represents the average annual yield of gold in California for thirty-three years, ending January 31, 1880, the faces of which are 4,397 feet square. The weight of such a cube of pure gold would be 102225.535 pounds avoirdupois, or fifty-one tons and two hundred and twenty-five and one half pounds, and its value in coin $30,832,608. The weight of the total yield for thirty-three years, in pure gold, would be 1688.75 tons, and its value, $1,017,476,065.

The following is an estimate of the total yield of gold from California, from its discovery by James W. Marshall, at Sutter's mill, on the nineteenth day of January, 1848, to January 1, 1882:

PRODUCTION OF GOLD FROM ITS DISCOVERY IN 1848, TO JANUARY 1, 1882.

Years.	Authorities.	Amount.
1848 to 1868 (inclusive)	W. P. Blake's Report on the Precious Metals, folio 21 (estimated)	$807,000,000
1869	Rossiter W. Raymond	20,000,000
1870	John Valentine	18,682,972
1871	Rossiter W. Raymond	16,167,484
1872	John Valentine	19,049,098
1873	Mining and Scientific Press (October 24, 1874)	18,052,722
1874	John Valentine	17,617,124
1875	John Valentine	16,326,211
1876	John Valentine	16,099,499
1877	John Valentine	15,237,729
1878	John Valentine	17,306,508
1879	John Valentine	18,190,973
1880	John Valentine	17,745,745
1881	John Valentine	17,166,674
Total		$1,034,642,739

Telegraphed to the San Francisco journals:

PRODUCTION OF PRECIOUS METALS.

WASHINGTON, June 22.—In the annual report of Director of the Mint, Burchard, he gives the following statistics of the bullion production of the country for the calendar year 1881: The gold production deposited at the Mints and assay offices is $34,250,000; undeposited exports, $160,000; undeposited, used in the arts, $270,000. Total, $34,700,000. This is a gain from the production of 1880 of over $1,250,000.

Of the gold production, about $26,000,000, or nearly four fifths of the whole, came from the Pacific Coast mines, including those in Idaho and Arizona, and was deposited with the San Francisco and Carson Mints, while nearly $8,000,000 were received at Philadelphia and New York from Colorado and Montana. The total gold production of the State of California, as nearly as can be ascertained by the Mint Bureau, was $18,200,000.

The production in California by counties was as follows:

Counties.	Gold.	Counties.	Gold.
Alpine	$2,000	Nevada	$3,700,000
Amador	1,450,000	Placer	850,000
Butte	650,000	Plumas	1,350,000
Calaveras	800,000	Sacramento	425,000
Colusa	3,500	San Bernardino	9,000
Del Norte	60,000	San Diego	60,000
El Dorado	350,000	Santa Barbara	2,000
Fresno	90,000	Shasta	350,000
Humboldt	75,000	Sierra	950,000
Inyo	170,000	Siskiyou	850,000
Kern	190,000	Stanislaus	630,000
Lassen	71,000	Tehama	5,000
Los Angeles	13,000	Trinity	550,000
Mariposa	200,000	Tulare	8,000
Mendocino	1,000	Tuolumne	500,000
Merced	1,500	Ventura	500
Modoc	20,000	Yuba	800,000
Mono	3,385,000		

The estimated production of gold in the hydraulic mines of California is from $12,000,000 to $14,000,000 annually, and the capital invested is $100,000,000.

TABLE OF AVERAGE YIELD OF GOLD,

From some of the principal Quartz Mines of the State of California—Compiled generally from newspaper reports.

Name of Mine.	Average value per ton.	Parts of quartz by weight required to yield one part gold
Amador County.		
Amador Consolidated	$20 00	30,147
Amador Original	28 00	21,533
Bunker Hill	10 00	60,293
Coney	13 50	44,662
Croft's	15 00	40,195
Golden Gate	16 00	37,683
Haywards	27 00	22,331
Hazard	15 00	40,195
Keystone	16 00	37,683
Kelley	14 00	43,067
Kennedy	16 00	37,683
Lincoln G. M. Co.	15 00	40,195
Loring	12 00	50,244
Mitchell	16 00	37,683
Oneida	17 50	34,453
Paugh	12 00	50,244
Pioneer	40 00	15,073
Phœnix	6 00	100,489
Railroad	15 00	40,195
Sirocco	15 00	40,195
Tellurium	25 00	24,117
County average	$17 33	--------
Placer County.		
Auburn	$15 00	40,195
Buckeye	32 50	18,552
Crater	42 00	13,399
Cooper	22 00	27,406
Consolidated Mines	10 00	60,293
Crandall	8 00	75,367
Elizabeth	28 00	21,533
Gold Blossom	7 50	80,391
Holder	30 00	20,097
Julian	9 00	66,993
Mina Rica	15 00	40,195
Orleans	15 00	40,195
Rising Sun	21 50	28,043
Spanish	9 00	66,993
St. Patrick	41 50	14,529
St. Lawrence	7 50	80,391
Scott	20 00	30,147
Shadyside	50 00	12,059
Solsie	40 00	15,073
County average	$22 29	--------
Nevada County.		
Antelope	$50 00	12,059
Anaha	60 00	10,049
California	19 00	31,712
California, Eureka District	15 00	40,195
Eureka	61 13	9,863
Empire	30 00	20,097
Gold Tunner	17 50	34,453
Idaho	37 91	15,904
New York Hill	45 00	13,399
Nevada	10 00	60,293
North Star	20 00	30,147
Pittsburgh	$65 00	9,122
Pittsburgh	36 00	16,748
County average	$35 89	--------
Calaveras County.		
Anton	$12 00	50,244
Beckman's	20 00	30,147
Everlasting	7 00	86,133
Garnet	8 50	70,936
La Chapelle	10 00	60,293
Pioneer Chief	7 50	80,391
Shot Gun	10 00	60,293
Thorpe's	8 50	70,936
Union	15 00	40,195
County average	$10 94	--------
Mariposa County.		
Buckeye	$40 00	15,073
Catron's	10 00	60,293
Josephine	8 00	75,367
Mariposa	14 00	43,067
Mt. Ophir	8 00	75,367
Pine Tree	9 00	66,993
Princeton	16 00	37,683
Washington	10 00	60,293
Hite's Cove	31 40	19,202
County average	$16 27	--------
Sierra County.		
Keystone	$20 00	30,147
Phœnix	20 00	30,147
Sierra Buttes	7 00	86,133
County average	$15 67	--------
El Dorado County.		
Cedarberg	$65 00	9,122
Mt. Pleasant	47 00	12,828
St. Lawrence	17 49	34,473
Taylor	12 00	50,244
Woodside	35 00	17,227
County average	$35 30	--------
Tuolumne County.		
App	$8 75	68,907
Confidence	16 00	37,683
Golden Gate	14 50	41,582
County average	$13 08	--------
Siskiyou County.		
Black Bear	$15 51	38,874
Klamath	10 00	60,293
Morning Star	16 50	36,541
County average	$14 00	--------

General average of eighty-five mines above mentioned, $21 22.

The following tables of the production of gold in California are taken from statistics of the production of the precious metals of the United States, tenth census, 1881:

Table No. I.

PRODUCTION OF THE PRECIOUS METALS.

Production of Deep Mines for the year ending May 31, 1880.

County and District.	Ore raised during census year.	Average Assay Value per ton.			Total Assay Value of Ore raised during census year.					Ore raised and treated.	Average Yield per ton.		
		Gold.	Silver.	Gold and Silver.	Gold.		Silver.		Totals.		Gold.	Silver.	Gold and Silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dollars.	Dollars.	Dollars.
AMADOR.													
Amador City (*a*)	38,112	18 67		18 67	34,422.7	711,580			711,580	38,112	15 45		15 45
Drytown	104	105 55		105 55	531.0	10,977			10,977	104	95 00		95 00
Jackson	26,620	8 16		8 16	10,504.8	217,153			217,153	20,620	8 16		8 16
Pine Grove	500	*35 00		*35 00	*846.5	*17,499			*17,499	18	31 50		31 50
Pioneer													
Plymouth	40,369	14 64		14 64	28,589.6	590,999			590,999	40,369	11 81		11 81
Sutter Creek	6,636	10 55		10 55	3,388.5	70,047			70,047	6,636	9 06		9 06
Volcano	2,277	25 13		25 13	2,773.3	57,329			57,329	2,277	20 14		20 14
Totals	114,618	14 62		14 62	81,056.4	1,675,584			1,675,584	108,136	12 49		12 49
CALAVERAS.													
Angels Camp	1,900	14 58		14 58	1,340.0	27,700			27,700	1,900	11 32		11 32
Carson Hill	3	*6,783 00		*6,783 00	*997.5	*20,620			*20,620	3	6627 00		6627 00
Independence	2,600	60 65		60 65	7,628.1	157,687			157,687	2,600	48 52		48 52
Mesquite	125	121 00		121 00	731.7	15,125			15,125				
Mokelumne Hill (*b*)	38,000	6 23		6 23	11,464.8	236,999			236,999	36,000	5 00		5 00
Washington													
Totals	**42,628**	10 74		10 74	22,162.1	458,131			458,131	40,503	8 58		8 58

EL DORADO.													
Kelsey													
Mud Spring, or Springfield	3,620	25 89		25 89	4,533.4	93,714			93,714	3,620	20 61		20 61
Placerville	900	27 72		27 72	1,298.9	26,850			26,850	900	24 75		24 75
Total	4,520	26 76		26 76	5,832.3	120,564			120,564	4,520	21 21		21 21
FRESNO.													
Potter Ridge (*c*)	578	150 00	13 00	163 00	4,194.1	86,700	5,812	7,514	94,214	578	120 00	10 40	130 40
Total	578	150 00	13 00	163 00	4,194.1	86,700	5,812	7,514	94,214	578	120 00	10 40	130 40
INYO.													
Alabama													
Beverage	354	*65 00		65 00	1,113.1	23,010			23,010	354	50 00		50 00
Cerro Gordo	4,223	94	83 86	84 80	191.2	3,952	273,962	354,206	358,158	4,223	79	33 27	34 06
Coso (*d*)	350	2 98	*55 94	58 92	50.5	1,044	15,144	19,580	20,624	350	2 68	50 35	53 03
Deep Spring Valley													
Fish Springs													
Kearsarge	200		*55 00	*55 00			8,508	*11,000	*11,000	200		47 00	47 00
Lee	100		*75 00	*75 00			5,806	*7,506	7,506	*100		65 00	65 00
Lookout (*e*)	260	2 80	80 00	82 80	35.2	728	16,088	20,800	21,528	260	2 43	71 15	73 58
Pajaro													
Panamint	600		*70 00	*70 00			32,480	41,994	41,994	600		61 90	61 90
Russ	500	*9 00	*8 00	*17 00	217.7	4,500	3,094	4,000	8,500	500	5 85	5 20	11 05
Snow's Cañon	100	4 00	17 00	21 00	19.3	399	1,315	1,700	2,099	100	2 00	13 00	15 00
Swansea	27		257 72	257 72			5,382	6,958	6,958	27		206 18	206 18
Tarrytown													
Ubehebe (*f*)													
Union													
Waucoba (*f*)													
Wild Rose													
Totals	6,714	5 01	69 66	74 67	1,627.0	33,633	361,779	467,744	501,377	6,714	3 83	35 62	39 45
LASSEN.													
Hayden Hill	2,079	21 08	63	21 71	*2,120.2	*43,828	*1,009	*1,305	*45,133	2,079	16 71	50	17 21
Totals	2,079	21 08	63	21 71	*2,120.2	*43,828	*1,009	*1,305	*45,133	2,079	16 71	50	17 21
LOS ANGELES.													
Silverado	200		160 00	160 00			24,750	32,000	32,000	200		147 00	147 00
Totals	200		160 00	160 00			24,750	32,000	32,000	200		147 00	147 00

*Estimated.

Table No. 1—Continued.

County and District.	Bullion Produced from Ore raised and treated during census year.					Ore raised, but not treated.	Assay Value of Ore raised during census year, and remaining on hand at close of year.					Bullion Produced during census year from Ore previously raised.				
	Gold.		Silver.		Totals.		Gold.		Silver.		Totals.	Gold.		Silver.		Totals.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dollars.	Ozs.	Dolls	Dollars.	Ounces.	Dollars.	Ozs.	Dolls	Dolls.
Amador.																
Amador City (*a*)	28,488.0	588,899			588,899							2,733.2	56,500			56,500
Drytown	477.9	9,879			9,879											
Jackson	8,146.4	168,401			168,401	6,000	435.4	9,001			9,001					
Pine Grove	27.4	567			567	482	816.1	16,870			16,870					
Pioneer																
Plymouth	23,070.1	476,901			476,901											
Sutter Creek	2,904.4	60,040			60,040											
Volcano	2,218.5	45,860			45,860											
Totals	65,332.7	1,350,547			1,350,547	6,482	1,251.5	25,871			25,871	2,733.2	56,500			56,500
Calaveras.																
Angel's Camp	1,040.0	21,499			21,499											
Carson Hill	967.5	20,000			20,000											
Independence	6,102.5	126,150			126,150											
Mesquite						125	731.6	15,124			15,124					
Mokelumne Hill (*b*)	8,707.5	180,000			180,000	2,000	580.5	12,000			12,000	48.4	1,000			1,000
Washington																
Totals	16,817.5	347,649			347,649	2,125	1,312.1	27,124			27,124	48.4	1,000			1,000
El Dorado.																
Kelsey																
Mud Springs or Springfield	3,608.8	74,601			74,601											
Placerville	1,077.8	22,280			22,280											
Totals	4,686.6	96,881			96,881											

FRESNO.																
Potter Ridge (*c*)	3,355.3	69,360	4,649	6,011	75,371							156.7	3,239	217	281	3,520
Totals	3,355.3	69,360	4,649	6,011	75,371							156.7	3,239	217	281	3,520
INYO.																
Alabama																
Beverage	856.2	17,699			17,699											
Cerro Gordo	160.0	3,307	108,684	140,517	143,824											
Coso (*d*)	45.4	939	13,630	17,622	18,561											
Deep Spring Valley																
Fish Springs																
Kearsarge			7,270	9,400	9,400											
Lee			5,027	6,500	6,500											
Lookout (*c*)	30.6	633	14,308	18,499	19,132											
Pajaro																
Panamint			28,726	37,140	37,140											
Russ	141.5	2,925	2,011	2,600	5,525											
Snow's Cañon	9.7	200	1,006	1,300	1,500											
Swansea			4,306	5,567	5,567											
Tarrytown																
Ubehebe (*f*)																
Union																
Waucoba (*f*)																
Wild Rose																
Totals	1,243.4	25,703	184,968	239,145	264,848											
LASSEN.																
Hayden Hill	1,680.5	34,739	802	1,037	35,776											
Totals	1,680.5	34,739	802	1,037	35,776											
LOS ANGELES.																
Silverado			22,740	29,400	29,400											
Totals			22,740	29,400	29,400											

TABLE No. 1—Continued.

County and District.	Ore raised during census year.	Average Assay Value per ton.			Total Assay Value of Ore raised during census year.					Ore raised and treated.	Average Yield per ton.		
		Gold.	Silver.	Gold and Silver.	Gold.		Silver.		Totals.		Gold.	Silver.	Gold and Silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dollars.	Dollars.	Dollars.
MARIPOSA.													
Coulterville	300	50 00		50 00	725.6	15,000			15,000	300	37 50		37 50
Hornitos (*g*)	12,000	15 00		15 00	8,707.5	180,000			180,000	12,000	9 00		9 00
Mariposa Estate (*h*)	4,360	20 62		20 62	4,349.9	89,920			89,920	4,360	15 78		15 78
Totals	16,660	17 10		17 10	13,783.0	284,920			284,920	16,660	10 69		10 69
MONO.													
Bishop Creek													
Blind Spring (*i*)	174	1 95	249 17	251 12	16.4	339	33,533	43,355	43,694	174	1 78	243 29	245 07
Bodie	56,072	53 00	8 17	61 17	143,756.5	2,971,711	354,235	457,990	3,429,701	55,969	49 42	6 10	55 52
Clover Patch													
Homer													
Indian	640		142 66	142 66			70,616	91,300	91,300	640		125 50	125 50
Montgomery, or White Peak	300		20 00	20 00			4,641	6,000	6,000	300		16 67	16 67
Piute													
Scattered	25		*300 00	*300 00			*5,801	*7,500	*7,500	25		264 04	264 04
Totals	57,211	51 95	10 59	62 54	143,772.9	2,972,050	468,826	606,145	3,578,195	57,108	48 44	8 33	56 77
NAPA.													
Calistoga													
Totals													
NEVADA.													
Grass Valley	28,989	20 26		20 26	28,408.7	587,260			587,260	28,989	15 19		15 19
Nevada City	27,814	22 57	1 05	23 62	30,374.9	627,905	22,328	28,868	656,773	27,814	14 25	68	14 93
Willow Valley	1,630	40 00		40 00	3,154.0	65,199			65,199	1,630	32 00		32 00
Totals	58,433	21 91	49	22 40	61,937.6	1,280,364	22,328	28,868	1,309,232	58,433	15 21	33	15 54

PLACER.													
Colfax (*j*)	3,000	25 00		25 00	3,628.1	75,000			75,000	3,000	20 00		20 00
Totals	3,000	25 00		25 00	3,628.1	75,000			75,000	3,000	20 00		20 00
PLUMAS.													
Genesee Valley	400	*9 75	*25	*10 00	188.6	3,899	77	100	3,999	400	7 00	05	7 05
Indian Valley (*k*)	37,960	8 72	12	8 84	16,016.4	331,088	3,254	4,207	335,295	37,960	6 11	08	6 19
Quartz Township (*l*)	74,919	*9 21	*08	*9 29	33,386.1	*690,152	4,486	*5,800	*695,952	74,919	6 91	06	6 97
Seneca	600	6 29	06	6 35	182.5	3,773	31	40	3,813	600	4 72	05	4 77
Totals	113,879	9 03	09	9 12	49,773.6	1,028,912	7,848	10,147	1,039,059	113,879	6 63	06	6 69
SAN BERNARDINO.													
Clark (*m*)	389		193 76	193 76			58,297	75,372	75,372	389		164 55	164 55
Dry Lake													
Silver Mountain	*100	*100 00	*82 00	*182 00	483.7	9,999	6,343	8,201	18,200				
Totals	489	20 45	170 90	191 35	483.7	9,999	64,640	83,573	93,572	389		164 55	164 55
SAN DIEGO.													
Banner	300	40 00		40 00	580.5	12,000			12,000	300	30 00		30 00
Corgo Muchacho	10,000	22 00		22 00	10,642.5	220,000			220,000	10,000	15 40		15 40
Julian	213	*52 81		*52 81	544.2	*11,250			*11,250	213	41 55		41 55
Picacho	6,000	21 00		21 00	6,095.2	125,999			125,999	6,000	11 00		11 00
Pinecate													
Totals	16,513	22 36		22 36	17,862.4	369,249			369,249	16,513	14 40		14 40
SHASTA.													
French Gulch	500	*85 00		*85 00	*2,055.9	*42,499			*42,499	*500	*77 00		*77 00
Iron Mountain													
Pittsburgh	6,000	*2 50	*18 00	*20 50	*725.6	*14,999	*83,533	*108,000	*122,999	6,000	*2 00	*14 90	*16 90
Whisky Creek	1,180	*44 32		*44 32	*2,530 0	*52,300			*52,300	1,180	34 49		34 49
Scattered	330	54 54		54 54	870.8	18,001			18,001	*200	*20 00		*20 00
Totals	8,010	*15 96	*13 48	*29 44	*6,182.3	*127,799	*83,533	*108,000	*235,799	7,880	12 08	*11 34	23 42

* Estimated.

Table No. 1—Continued.

County and District.	Bullion Produced from Ore raised and treated during census year.					Ore raised but not treated.	Assay Value of Ore raised during census year and remaining on hand at close of year.					Bullion Produced during census year from Ore previously raised				
	Gold.		Silver.		Totals.		Gold.		Silver.		Totals.	Gold.		Silver.		Totals.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dollars.	Ozs.	Dollars.	Dollars.	Ounces.	Dollars	Ozs.	Dollars.	Dollars.
MARIPOSA.																
Coulterville	554.2	11,250			11,250											
Hornitos (*g*)	5,224.5	108,000			108,000							25.4	525			525
Mariposa Estate (*h*)	3,328.2	68,800			68,800							6,467.7	133,699			133,699
Totals	9,096.9	188,050			188,050							6,493.1	134,224			134,224
MONO.																
Bishop Creek																
Blind Spring (*i*)	14.9	308	32,743	42,333	42,641									696	900	900
Bodie	133,801.7	2,765,927	264,038	341,375	3,107,302	103	138.1	2,855	939	1,214	4,069					
Clover Patch																
Homer																
Indian			62,122	80,317	80,317											
Mont'gy, or Wh. Peak			3,867	5,000	5,000											
Piute																
Scattered			5,105	6,601	6,601											
Totals	133,816.6	2,766,235	367,875	475,626	3,241,861	103	138.1	2,855	939	1,214	4,069			696	900	900
NAPA.																
Calistoga																
Totals																
NEVADA.																
Grass Valley	21,306.5	440,445			440,445											
Nevada City	19,171.2	396,303	14,737	19,053	415,356											
Willow Valley	2,523.2	52,159			52,159											
Totals	43,000.9	888,907	14,737	19,053	907,960											

PLACER.																
Colfax (*j*)	2,902.5	60,000			60,000							387.0	8,000			8,000
Totals	2,902.5	60,000			60,000							387.0	8,000			8,000
PLUMAS.																
Genesee Valley	135.4	2,799	15	20	2,819											
Indian Valley (*k*)	11,224.6	232,033	2,206	2,852	234,885							28.1	581	5	7	588
Quartz Township (*l*)	25,039.6	517,614	3,364	4,349	521,963							47.1	974	8	10	984
Seneca	136.9	2,830	23	30	2,860							2,077.4	42,943	8	10	42,953
Totals	36,536.5	755,276	5,608	7,251	762,527							2,152.6	44,498	21	27	44,525
SAN BERNARDINO.																
Clark (*m*)			49,540	64,050	64,050									824	1,065	1,065
Dry Lake																
Silver Mountain						100	483.7	9,999	6,342	8,200	18,199					
Totals			49,540	64,050	64,050	100	483.7	9,999	6,342	8,200	18,199			824	1,065	1,065
SAN DIEGO.																
Banner	435.4	9,000			9,000											
Corgo Muchacho	7,449.7	154,000			154,000											
Julian	428.1	8,850			8,850											
Picacho	3,192.8	66,000			66,000											
Pinecate																
Totals	11,506.0	237,850			237,850											
SHASTA.																
French Gulch	*1,862.4	*38,500			*38,500											
Iron Mountain																
Pittsburgh	*580.5	*12,000	*69,145	*89,398	*101,398							58.1	1,201	6,914	8,939	10,140
Whisky Creek	1,968.9	40,700			40,700											
Scattered	193.5	4,000			4,000	130	628.9	13,001			13,001					
Totals	4,605.3	95,200	*69,145	*89,398	184,598	130	628.9	13,001			13,001	58.1	1,201	6,914	8,939	10,140

* Estimated.

TABLE No. 1—Continued.

COUNTY AND DISTRICT.	Ore raised during census year.	Average Assay Value per ton.			Total Assay Value of Ore raised during census year.					Ore raised and treated.	Average Yield per ton.		
		Gold.	Silver.	Gold and Silver.	Gold.		Silver.		Totals.		Gold.	Silver.	Gold and Silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dollars.	Dollars.	Dollars.
SISKIYOU.													
Quartz Valley	500	26 13	11 72	37 85	632.0	13,064	4,533	5,861	18,925	500	19 59	8 79	28 38
Sawyer's Bar	2,500	17 75	25	18 00	2,146.7	44,376	483	625	45,001	2,500	13 02	12	13 14
South Fork Salmon	19,290	*11 12	*15	*11 27	*10,375.2	*214,475	2,201	*2,845	*217,320	19,290	8 34	11	8 45
Totals	22,290	12 20	44	12 64	13,153.9	271,915	7,217	9,331	281,246	22,290	9 11	31	9 42
TRINITY.													
Ballychoop	*400	*30 00	------	*30 00	580.5	*12,000	------	------	*12,000	*400	*25 00	------	*25 00
Deadwood	400	*40 00	------	*40 00	774.0	*16,000	------	------	*16,000	400	30 00	------	30 00
Totals	800	*35 00	------	*35 00	1,354.5	*28,000	------	------	*28,000	800	27 50	------	27 50
TUOLUMNE.													
Confidence	*3,006	*12 44	------	*12 44	*1,808.3	*37,380	------	------	*37,380	*3,006	*10 40	------	*10 40
Jamestown	2,200	*25 00	------	*25 00	2,660.6	55,000	------	------	55,000	2,200	*20 00	------	*20 00
Riverside	200	15 00	------	15 00	145.1	3,000	------	------	3,000	200	10 00	------	10 00
Sonora	3,000	8 60	------	8 60	1,248.4	25,806	------	------	25,806	3,000	8 00	------	8 00
Soulsbyville (*n*)	2,000	*18 00	*2 00	*20 00	*1,741.5	*36,000	3,094	*4,000	*40,000	2,000	13 50	1 50	15 00
Totals	10,406	15 11	38	15 49	7,603.9	157,186	*3,094	*4,000	161,186	10,406	12 32	29	12 61

* Estimated.
a From tailings.
b From 500 tons tailings.
c From 27 tons ore prior to census year.
d Lead 30 per cent.
e Lead 30 per cent=62 tons.
f Abandoned.
g From 175 tons tailings.

Table No. 1—Continued.

County and District.	Bullion Produced from Ore raised and treated during census year.					Ore raised but not treated.	Assay Value of Ore raised during census year and remaining on hand at close of year.					Bullion Produced during census year from Ore previously raised.				
	Gold.		Silver.		Totals.		Gold.		Silver.		Totals.	Gold.		Silver.		Totals.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.	Ozs.	Dolls.	Ozs.	Dolls.	Dolls.
SISKIYOU.																
Quartz Valley	474.0	9,798	3,400	4,396	14,194											
Sawyer's Bar	1,574.6	32,550	223	288	32,838											
South Fork Salmon	7,781.4	160,856	1,650	2,134	162,990											
Totals	9,830.0	203,204	5,273	6,818	210,022											
TRINITY.																
Ballychoop	*483.7	*10,000			*10,000											
Deadwood	580.5	12,000			12,000											
Totals	1,064.2	22,000			22,000											
TUOLUMNE.																
Confidence	*1,512.2	*31,260			*31,260											
Jamestown	*2,128.5	*44,000			*44,000											
Riverside	96.7	2,000			2,000											
Sonora	1,161.0	24,000			24,000											
Soulsbyville (n)	1,306.1	27,000	2,320	3,000	30,000							73.1	1,511	146	189	1,700
Totals	6,204.5	128,260	2,320	3,000	131,260							73.1	1,511	146	189	1,700

* Estimated.
h From 7,640 tons raised prior to census year.
i From 48 tons tailings.
j From 1,000 tons tailings.
k From 236 tons ore prior to census year.
l From 302 tons tailings.
m From 270 tons tailings.
n From tailings sold.

TABLE No. II.

RECAPITULATION BY COUNTIES OF PRODUCTION OF DEEP MINES FOR THE YEAR ENDING MAY 31, 1880.

County.	Ore raised during census year.	Average Assay Value per ton.			Total Assay Value of Ore raised during census year.					Ore raised and treated.	Average Yield per ton.		
		Gold.	Silver.	Gold and Silver.	Gold.		Silver.		Totals.		Gold.	Silver.	Gold and Silver.
	Tons.	Dollars.	Dollars.	Dollars.	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Dolls.	Dolls.	Dolls.
Amador	114,618	14 62		14 62	81,056.4	1,675,584			1,675,584	108,136	12 49		12 48
Calaveras	42,628	10 74		10 74	22,162.1	458,131			458,131	40,503	8 58		8 58
El Dorado	4,520	26 76		26 76	5,832.3	120,564			120,564	4,520	21 21		21 21
Fresno	578	150 00	13 00	163 00	4,194.1	86,700	5,812	7,514	94,214	578	120 00	10 40	130 40
Inyo	6,714	5 01	69 66	74 67	1,627.0	33,633	361,779	467,744	501,377	6,714	3 83	35 62	39 45
Lassen	2,079	21 08	63	21 71	*2,120.2	*43,828	*1,009	*1,305	*45,133	2,079	16 71	50	17 21
Los Angeles	200		160 00	160 00			24,750	32,000	32,000	200		147 00	147 00
Mariposa	16,660	17 10		17 10	13,783.0	284,920			284,920	16,660	10 69		10 69
Mono	57,211	51 95	10 59	62 54	143,772.9	2,972,050	468,826	606,145	3,578,195	57,108	48 44	8 33	56 77
Nevada	58,433	21 91	49	22 40	61,937.6	1,280,364	22,328	28,868	1,309,232	58,433	15 21	33	15 54
Placer	3,000	25 00		25 00	3,628.1	75,000			75,000	3,000	20 00		20 00
Plumas	113,879	9 03	09	9 12	49,773.6	1,028,912	7,848	10,147	1,039,059	113,879	6 63	06	6 69
San Bernardino	489	20 45	170 90	191 35	483.7	9,999	64,640	83,573	93,572	389		164 55	164 55
San Diego	16,513	22 36		22 36	17,862.4	369,249			369,249	16,513	14 40		14 40
Shasta	8,010	*15 96	*13 48	*29 44	*6,182.3	*127,799	*83,533	*108,000	*235,799	7,880	12 08	*11 34	23 42
Siskiyou	22,290	12 20	44	12 64	13,153.9	271,915	7,217	9,331	281,246	22,290	9 11	31	9 42
Trinity	800	*35 00		*35 00	*1,354.5	*28,000			*28,000	800	27 50		27 50
Tuolumne	10,406	15 11	38	15 49	7,603.9	157,186	*3,094	*4,000	161,186	10,406	12 32	29	12 61
Totals	479,028	18 84	2 84	21 68	436,528.0	9,023,834	1,050,836	1,358,627	10,382,461	470,088	16 10	2 00	18 10
Additional production estimated from transportation statistics	*65,213	*18 84	*2 84	*21 68	59,434.1	*1,228,612	143,248	*185,205	*1,413,817	*65,213	*16 10	*2 00	*18 10
Grand Totals	544,241	18 84	2 84	21 68	495,962.1	10,252,446	1,194,084	1,543,832	11,796,278	535,301	16 10	2 00	18 10

* Estimated.

TABLE No. II—Continued.

County.	Bullion Produced from Ore raised and treated during census year.					Ore raised but not treated.	Assay Value of Ore raised during census year and remaining on hand at close of year.					Bullion Produced during census year from Ore previously raised				
	Gold.		Silver.		Totals.		Gold.		Silver.		Totals.	Gold.		Silver.		Totals.
	Ounces.	Dollars.	Ounces.	Dollars.	Dollars.	Tons.	Ounces.	Dolls.	Ozs.	Dolls.	Dolls.	Ounces.	Dollars.	Ozs.	Dolls.	Dolls.
Amador	65,332.7	1,350,547			1,350,547	6,482	1,251.5	25,871			25,871	2,733.2	56,500			56,500
Calaveras	16,817.5	347,649			347,649	2,125	1,312.1	27,124			27,124	48.4	1,000			1,000
El Dorado	4,686.6	96,881			96,881											
Fresno	6,355.3	69,360	4,649	6,011	75,371							156.7	3,239	217	281	3,520
Inyo	1,243.4	25,703	184,968	239,145	264,848											
Lassen	1,680.5	34,739	802	1,037	35,776											
Los Angeles			22,740	29,400	29,400											
Mariposa	9,096.9	188,050			188,050							6,493.1	134,224			134,224
Mono	133,816.6	2,766,235	367,875	475,626	3,241,861	103	138.1	2,855	939	1,214	4,069			696	900	900
Nevada	43,000.9	888,907	14,737	19,053	907,960											
Placer	2,902.5	60,000			60,000							387.0	8,000			8,000
Plumas	36,536.5	755,276	5,608	7,251	762,527							2,152.6	44,498	21	27	44,525
San Bernardino			49,549	64,050	64,050	100	483.7	9,999	6,342	8,200	18,199			824	1,065	1,065
San Diego	11,506.0	237,850			237,850											
Shasta	4,605.3	95,200	*69,145	*89,398	184,598	130	628.9	13,001			13,001	58.1	1,201	6,914	8,939	10,140
Siskiyou	9,830.0	203,204	5,273	6,818	210,022											
Trinity	1,064.2	22,000			22,000											
Tuolumne	6,204.5	128,260	2,320	3,000	131,260							73.1	1,511	146	189	1,700
Totals	351,679.4	7,269,861	727,657	940,789	8,210,650	8,940	3,814.3	78,850	7,281	9,414	88,264	12,102.2	250,173	8,818	11,401	261,574
Additional production estimated from transportation statistics	50,790.1	*1,049,925	100,879	*130,426	*1,180,351											
Grand Totals	402,469.5	8,319,786	828,536	1,071,215	9,391,001	8,940	3,814.3	78,850	7,281	9,414	88,264	12,102.2	250,173	8,818	11,401	261,574

Table No. III.

Production (Gold) of Hydraulic, Placer, Drift, and River Mines, for the year ending May 31, 1880.

County and District.	Gold. Totals, by Districts. Ounces.	Gold. Totals, by Districts. Dollars.	Gold. Totals, by Counties. Ounces.	Gold. Totals, by Counties. Dollars.
BUTTE.				
Centerville and Helltown	725.6	15,000	15,730.3	325,174
Cherokee Flat	13,257.5	274,057		
Magalia or Dog Town	828.1	17,118		
Morris Ravine	435.4	9,000		
Oroville	483.7	9,999		
CALAVERAS.				
Mokelumne Hill	3,069.4	63,450	4,665.8	96,451
Robinson's Ferry	725.6	15,000		
Vallecito	870.8	18,001		
DEL NORTE.				
Scattered	6,208.0	128,331	6,208.0	128,331
EL DORADO.				
Scattered	*24,877.7	*514,268	*24,877.7	*514,268
HUMBOLDT.				
Gold Bluffs	1,306.1	27,000	3,724.9	77,001
Orleans Bar	2,418.8	50,001		
MONO.				
Bodie	1,219.0	25,199	1,219.0	25,199
NEVADA.				
Scattered	2,062.3	42,631	2,062.3	42,631
PLACER.				
Bath	3,144.4	65,000	13,998.2	289,368
Dutch Flat	2,128.5	44,000		
Gold Run	2,612.2	53,999		
Iowa Hill	774.0	16,000		
Michigan Bluffs	5,339.1	110,369		
PLUMAS.				
Claremont	----	----	7,946.0	164,259
Light's Cañon	290.2	5,999		
Moonlight Mountain	290.3	6,001		
North Fork, Feather River	4,081.7	84,376		
Seneca	340.3	7,035		
Scattered	2,943.5	60,848		
SHASTA.				
Buckeye	696.6	14,400	21,789.7	450,432
French Gulch	1,393.8	28,813		
Igo	----	----		
Northern Shasta County	5,201.3	107,520		
Sawmill Flat	182.8	3,779		
Shasta City	1,253.9	25,920		
Southern Shasta County	10,158.8	210,000		
Scattered	2,902.5	60,000		
Amount carried forward	----	----	102,221.9	2,113,114

*Estimated.

Table No. III—Continued.

County and District.	Gold — Totals, by Districts. Ounces.	Gold — Totals, by Districts. Dollars.	Gold — Totals, by Counties. Ounces.	Gold — Totals, by Counties. Dollars.
Amount brought forward			102,221.9	2,113,114
SISKIYOU.				
Callahan's Ranch	3,984.7	82,371	23,413.1	483,992
Cottonwood	580.5	12,000		
Galena Hill	483.8	10,001		
Greenhorn	657.9	13,600		
Humbug	1,879.4	38,851		
Indian Creek	712.4	14,726		
McAdam's Creek	2,419.5	50,015		
Oro Fino	943.5	19,503		
Rattlesnake Creek	314.4	6,500		
Sawyer's Bar	3,628.1	75,000		
Sciad Valley	205.1	4,240		
Scott Valley	725.6	15,000		
South Fork, Salmon River	3,773.3	78,001		
Yreka	3,104.9	64,184		
STANISLAUS.				
Lagrange	3,030.7	62,650	3,030.7	62,650
TRINITY.				
Arkansas Bar	37,635.7	777,999	37,635.7	777,999
Ballychoop				
Boalt's Hill				
Buckeye Mountain				
Cañon Creek				
Coffee Creek				
Cox's Bar				
Douglas City				
Hay Fork				
Indian Creek				
Junction City				
Minersville				
New River				
Oregon Gulch				
Red Hill				
South Fork				
Taylor's Flat				
Trinity Center				
Weaver Basin				
TUOLUMNE.				
Big Oak Flat	*27,081.7	*559,828	*27,081.7	*† 559,828
Chinese Camp				
Groveland				
Jacksonville				
Montezuma				
Scattered				
YUBA.				
Scattered	*50,423.6	*1,042,349	*50,423.6	*1,042,349
Totals	243,806.7	5,039,932	243,806.7	5,039,932
Additional production estimated from transportation statistics			*171,298.3	*3,541,050
Grand Totals			415,105.0	8,580,982

*** Estimated. † Including $300,000 from "pocket" mines.**

AUSTRALIA.

Probably no other country in the world has been so prolific in its yield of gold as Australia. The existence of the precious metal was long known in the colonies before its discovery was publicly announced by E. H. Hargraves, in 1851. The first discovery was made in 1839, by Count Strzelecki, who made his discovery known to Governor Gipps, who warned him of the impossibility of controlling 45,000 convicts under the state of excitement which must surely follow the announcement of the discovery of gold fields. For this reason no publicity was given. Gold was discovered in 1841 by the Rev. W. B. Clarke, a gentleman to whom the Australians are indebted for many other discoveries, and who was known to the scientific world as a geologist of the highest standing. In the year 1843 he gave information to Sir George Gipps, still Governor of New South Wales, but it was thought best not to make it known, as it was thought the excitement would be prejudicial to the general interests of the colony; but when Hargraves returned from California and found the precious metal in great quantities, it was impossible longer to conceal it, and the excitement and extraordinary output of gold that followed is historical. Nearly all the Australian colonies were subsequently found to be gold producing. The official announcement of the discovery of gold in New South Wales was made September 18, 1851. The discovery of gold in Victoria was officially made August 25, 1851. New South Wales produced from 1851 to 1864, inclusive, 6,063,576 ounces; South Australia and Tasmania, from 1852 to 1860, inclusive, 93,500 ounces; and Victoria, from 1851 to 1865, inclusive, 30,422,591 ounces.

Production of Victoria gold fields (Ure's Dictionary) 1856, 3,947,160 ounces.

EXPORTS OF GOLD FROM AUSTRALIA.

Years.	Pounds sterling.	Dollars.
1851	907,113	4,390,426 92
1852	9,735,903	47,121,770 52
1853	10,445,700	50,557,188 00
1854	9,028,759	43,699,193 56
1855	11,513,230	55,724,033 20
1856	12,740,480	61,663,923 20
1857	11,764,299	56,939,207 16
Totals	66,135,484	320,095,742 56

EXPORTS OF GOLD FROM NEW SOUTH WALES.

Years.	Pounds sterling.	Dollars.
1851	468,336	2,266,746 24
1852	2,660,946	12,878,978 64
1853	1,781,172	8,620,872 48
1854	773,209	3,742,331 56
1855	209,250	1,012,770 00
1856	138,006	667,949 04
1857 to March 31	64,081	310,152 04
Totals	6,095,000	29,499,800 00

NEW ZEALAND.

Gold was first discovered at Massacre Bay in 1842. In 1852 new discoveries were made in Auckland and in Otago. Numerous discoveries have been made from time to time which have led to extensive workings. The sands on the ocean beaches contain gold, and are worked as similar sands are worked in Oregon and California. Total value of gold produced to January 30, 1865, £7,646,809, and number of ounces 1,947,667; total export to December, 1864, 1,749,359 ounces.

GOLD YIELD OF THE WORLD.

The estimated amount of gold in existence, as given in the London Engineer, at various times, was as follows:

At the Christian Era	$427,000,000
In 1492	57,000,000
In 1600	105,000,000
In 1700	351,000,000
In 1800	1,251,000,000
In 1843	2,000,000,000
In 1853	3,000,000,000
In 1860	4,000,000,000
In 1870	5,950,000,000
Estimated amount of gold and silver taken from the earth from the commencement of the Christian Era to the discovery of America	3,600,000,000
From that date to close of 1842	2,800,000,000
Up to 1860 Russia adds	746,000,000
Up to 1860 California and Australia add	2,000,000,000

Russian mines were discovered in 1819; Californian in 1848, and Australian in 1851.

Total average yield of the gold of the world brought to the European markets from 1790 to 1802, as given in pounds avoirdupois by Ure. The reduction to dollars is made on the assumption that an avoirdupois pound of pure gold is worth $301 46. It is not stated whether or not Ure's estimate was for pure gold, for which reason the calculation to dollars is only approximative:

Country.	Weight in Pounds Av.	Value.
Asia	3,740	$1,127,460 40
Africa	3,300	994,818 00
Europe—Hungary	1,430	431,087 80
Salsbourg	165	49,740 90
Austria, Italy, Hartz and Hessia, Saxony, Norway, Sweden, France, Spain, etc	165	49,740 90
North America	2,860	862,175 60
South America—Spanish Dominion	22,000	6,632,120 00
Brazil	15,400	4,642,484 00
Totals	49,060	$14,789,627 60

Mr. Berkmyre estimates the world's gold yield for 1846, not including Japan and China, in pounds sterling, as follows:

North and South America	£1,301,560
Russia	3,414,427
Austria	282,750
Piedmont, Spain, and North Germany	20,696
Africa	203,900
Borneo	305,900
Ava, Malacca, and other countries	317,519
Total	£5,846,752

Which, reduced to dollars, would be $28,298,279.

ESTIMATES OF THE GOLD YIELD OF THE WORLD FOR THE YEAR 1879.

Figures principally taken from the report of Director of the United States Mint for 1880. California yield, from tables published by John Valentine, General Superintendent of Wells, Fargo & Co., for that year:

Country.		Amount.	Per cent.
Africa		$1,993,800	1.892
Australia, including New Zealand		29,018,223	27.540
Europe—Germany	$205,361		
Austria	1,062,031		
Sweden	1,994		
Italy	72,375		
Russia	26,584,000		
		27,925,761	26.504
Japan		466,548	.443
South America		6,072,346	5.763
North America—California	$18,190,973		
Other States and Territories	20,708,885		
Mexico	989,161		
		39,889,019	37.858
Totals		$105,365,697	100.000

California produced 17.265 per cent. of the total yield of the world; 45.604 per cent. of the yield of North America; and 46.764 per cent. of the yield of the United States.

IRON ORES AND IRON INDUSTRIES OF CALIFORNIA.

Few countries consume so much iron in proportion to their population as California, notwithstanding this metal has here always commanded extra high prices. This comparatively large consumption grows out of our considerable requirements for mining purposes, and the extent to which we employ this material in building houses, fences, bridges, etc., the high prices we have had to pay for it, being due to the fact that our supplies have been imported from distant sources of production, subjecting them to heavy freights and other charges, and compelling dealers to keep large and varied stocks constantly on hand. The destructive fires that so frequently occurred in the early history of the State led to a free use of iron in the erection of warehouses, stores, and other business structures in cities and larger towns. Additional demands meantime had sprung up for the outfitting of quartz mills, hydraulic plant, etc., the growth of such demands keeping pace with the expansion of these several branches of mining. The substitution of iron pipes for wooden flumes for conveying water across rivers, ravines, and other depressions, has also called for a good deal of iron. Then came the era of railroad construction, adding immensely to other causes of iron absorption, all of which have kept on year by year undergoing steady enlargement. Besides supplying the Pacific States and Territories, our shops and foundries have turned out great quantities of mining machinery and castings for northwestern Mexico, South and Central America, and British Columbia, with some products in this line for China, Japan, and the islands of the Pacific, the Hawaiian sugar planters having here obtained all their mills, pans, etc. But with requirements so great and the raw material of superior quality scattered abundantly all over the State, not until recently were any well-directed and effectual efforts made to manufacture iron in California, the cost of production and fear of foreign competition having deterred even the most enterprising from undertaking it. Although companies had before been formed for producing this metal here, and even taken some preliminary steps in the business, not until 1880 was any purpose of this kind prosecuted to a determinate and successful issue.

QUANTITY AND COST OF IRON USED.

The annual consumption of pig iron on this coast during the past ten years has averaged about 14,000 tons, nearly as much more iron in the shape of bars, sheets, and in other forms, having meantime been consumed. The whole of this, with the exception of some little made in Oregon, has, up till the past year, been imported from the Eastern States and Europe, mostly from the latter. As the price of pig iron in San Francisco has averaged thirty dollars per ton, and of other kinds at least three times as much, our annual expenditures on account of this item have amounted to $1,350,000—$13,500,000 for the above period, and $35,000,000 or $40,000,000 since the State was founded. That such a drain upon our means should have been suffered to go on so long without any effectual steps being taken to check it, does not argue well for either the thrift or the enterprise of our people; more especially as we possess the raw material in such profusion, as well as the skill and capital requisite for transforming it into useful shapes. What has tended to somewhat relieve the stringency of the iron question here has been the manner in which the extensive rolling mills, erected in San Francisco some fifteen years ago, have since been able to work up the large quantities of old iron that before were either thrown aside as useless, or gathered up and shipped out of the country. Except as affected by the product of these rolling mills, our iron market has, until lately, been without any competitive check. Besides filling orders for iron in cases of emergency, and which could otherwise have been filled only after a long delay, these mills have, in a general way, rendered valuable service to all our other industries. Nevertheless, many of our vital interests have suffered materially through long neglect to produce at home this article of prime necessity.

IRON WORKS AND DEPOSITS IN WASHINGTON AND OREGON.

In 1866 the Oswego Company commenced making iron in the State of Oregon, their first blast having been made in August of that year. Their smelting works are located on the west bank of the Willamette River, seven miles south from the City of Portland, where they own 2,000 acres of land, much of it mineral bearing, and covered with a heavy growth of timber. Their mine, which is well opened with inclines, shafts, and tunnels, is distant three miles from their furnace, with which it is connected by railroad. Since starting, the company have met with many reverses, pecuniary and otherwise, whereby their operations have been seriously interrupted, and the success of the enterprise at times imperiled. Having, through persistent efforts, and some change of management, outlived these disasters, the company appears now to be in a prosperous condition, having, last season, completed a blast of 8,000 tons of ore, producing metal to the value of $150,000, which product, it is expected, will be exceeded the present year. In 1880 the company made 3,490 tons of iron, and, in 1881, about 5,000 tons, the most of which found ready sale in Portland and San Francisco, which points are reached by water transportation. In 1879 the company shipped 1,237 tons of iron to San Francisco, which amount was largely increased the following year, the product of their works meeting with general favor. They have plenty of ore, of the brown hematite variety, said to yield from forty to fifty per cent. metal. This company uses charcoal for fuel, and turns out twenty tons of marketable iron daily. Their motive power is steam; the working force employed, 250 men, the most of them as miners, teamsters, wood choppers, and charcoal burners.

The mines and smelting works of the Irondale Company are situated near Port Townsend, Washington Territory. This is an enterprise of recent origin, and is being carried on mostly by California capital. The deposits here are said to exist under much the same conditions as those of the Oswego Company, the ore being a brown hematite, wood abundant, and facilities for water transportation at hand. Having started so recently, this company have not yet made much iron; but having gotten fairly under way, they will probably keep up active operations hereafter. With an auspicious beginning, and such favorable surroundings, a prosperous future may be anticipated for this undertaking.

IRON DEPOSITS OF CALIFORNIA.

As before remarked, beds and veins of iron ores are widely distributed over California, our wealth in this mineral being surpassed by that of few other countries in the world. We have iron fields in the northern, central, and southern counties, and even far out on the deserts that occupy the northeastern and southeastern angles of the State. Iron ore occurs in great reefs, high up in the Sierra Nevada, and even in notable quantity among the sands along the ocean beach. We do not claim to have mountains of this metal, but in our inexhaustible deposits we have what amounts practically to the same thing. These most useful of all ores are found here, not only at many points and in the greatest profusion, but they are varied in kind and excellent in quality.

IRON ORES IN SHASTA COUNTY.

Throughout the whole tier of our northern counties iron ore, at least on the surface, is met with. The deposits near Crescent City, though not much explored, are apparently extensive, and being close to an eligible shipping point will, no doubt, prove valuable. In Shasta County the ores of this metal are especially abundant. At Iron Mountain, situate a short distance north from the town of Shasta and three miles west of the Sacramento River, exists an immense bed of iron ore. The deposit crops out on the mountain side, exposing thousands of tons of ore in place, detached masses of great size being also scattered over the surface of the ground adjacent. As there is limestone and timber not far off, this mine could be profitably worked by bringing the ore, fuel, and flux together on the railroad, when it comes to be extended north from Redding, the present terminus, as it soon will be. As this property belongs to men of large means, something will probably be done with it when the railroad is advanced to a point opposite the mine, and from which it will be but three miles distant.

IN SIERRA COUNTY.

At a point twelve miles northeast of Downieville, and at an elevation of 6,200 feet above sea level, occur very extensive deposits of magnetic iron ore, much of which carries from forty to fifty per cent. of metal. This ore is, much of it, of extreme high grade. Touching the character and extent of these deposits, Baron Von Richthoven, in a report upon the same to the owners, remarks as follows: "Your mines consist altogether of magnetic iron ores, the same from which the celebrated Swedish and Russian iron is manufactured. A total amount of ore which may be extracted from the different deposits, by quarrying, I estimate at about 1,400,000 tons—average yield, from forty-five to fifty per cent. Even the removal of the ore next the surface will be the work of a generation." The ore here is represented to be so highly magnetic that it not only attracts the needle, but possesses polarity. This ore is found in three conditions—massive, with a bright steel luster, intermixed with carbonate of lime, and interspersed, in the form of crystals, through chlorite and talcose slate. Thousands of tons of it could be readily mined, and there is plenty of wood and water in the vicinity, but the deposits are so remote, and at present so difficult of access, that they possess little or no commercial value. In working them, nearly eighty miles of wagon transportation, over mountain roads, would have to be made, at a cost of $20, or more, per ton. With a railroad leading to Oroville, or through the mountains to some point on the Central Pacific, the ores here could no doubt be reduced with profit.

BLACK SAND.

Mixed with the sand on the ocean shore, and extending for long distances both to the north and south of San Francisco, are immense quantities of magnetic iron ore, and which occurring in the form of small particles, constitute a considerable portion of these beach sands. A sample of this sand, taken from a drift near the end of the California Street Railroad, San Francisco, partly concentrated by the wind, contained 5.63 per cent of magnetite. Deposits of a similar character are abundant along the entire coast line of the State. It would, of course, be practicable to separate this ore from the silicious particles with which it is intermixed, by washing, or by the use of magnets, as practiced in some other countries; a process with which we, but for our more available deposits elsewhere, might be tempted to experiment. This magnetic sand makes iron of such superior quality, that it has, in some places, long been employed for that purpose. At Moisic, in Canada, and also in northern New York, this class of ore is extensively smelted after being separated from its associated earthy impurities through the employment of magnets, which perform the work cheaply and quickly. In some cases, the massive ore is pulverized, in order to be cleaned in this manner.

The California Iron Company was organized in the month of January, 1880. The company inaugurated active operations immediately thereafter, extensive tracts of iron producing and timber bearing lands, at and in the vicinity, having previously been secured. During the first year, dams, roads, and bridges, some of them very costly structures, were built; houses, shops, and other out-buildings put up, and the very complete blast furnace erected. Expensive machinery, including a powerful steam engine, was gotten on the ground and put in place, the propulsive power here employed being steam. Although operations in the field were consigned to seemingly competent hands, the company did not wholly escape the blunders and mishaps which at the outlet are so apt to attend ventures of this kind. Some of the work, owing perhaps to a lack of proper supervision or planning, proved so defective as to necessitate extensive repairs, and, in some cases, entire rebuilding, within a very short time after they were finished.

But, despite these disasters and troubles, the company succeeded in advancing their works with a good deal of rapidity, getting their furnace, which has a smelting capacity of fifty tons per day, ready for operations in April, 1881. The product of this furnace for that year amounted to 4,260 tons of pig iron—being at the rate of about

500 tons per month for the time it was in blast. The monthly product made by this company during the first half of 1882, and up to the time of their retirement from business, having been somewhat larger than during the preceding year.

The metal made by them has met with ready sale, at extreme prices, having been regarded with great favor by all classes of iron workers and dealers, who prefer it to the best imported brands, it being, in fact, actually worth from $8 to $10 per ton more than the latter.

The following description of this furnace was written immediately after my second visit, in May, 1881:

No person not acquainted with the subject can form a correct idea of the magnitude of the plant required to produce common cast iron economically, or the cost of such works. If informed that several hundred thousand dollars can be used in the construction of a first-class iron furnace, the figures would seem excessive, but in the manufacture of steel, which is simply cast iron purified, the cost of the plant is still greater. A moderately complete Bessemer works is worth $500,000 and upward: very complete and perfect works at Joliet, Illinois, cost $2,250,000.

The modern iron blast furnace is a marvel of scientific and mechanical skill, which seems to have reached a state near to perfection. While its first cost is very great, the vast amount of work that can be obtained from it admits of a satisfactory profit on the capital invested.

The newly constructed iron furnace in Placer County is as complete and perfect as can be made by united capital and skill. The capital employed is owned by the following well known San Francisco business men: Egbert Judson, Irving M. Scott, and A. P. Hotaling. The works are located about six miles from Auburn and about four miles from Clipper Gap; the exact locality is the northwest quarter of section 15, township 13 north, range 8 east, Mount Diablo base and meridian.

The furnace is known as a "charcoal hot blast iron furnace." It is a perfect duplicate of one built in 1873 on the Menominee River, which forms the boundary between Michigan and Wisconsin. The California furnace was built by Mr. James M. White, of Rochester, New York. Mr. White has been employed for years at the East in the construction of iron works, and to him is due the entire credit for the building and management of the California furnace. The credit for the inception of the enterprise is due to Mr. P. Fitzhue.

The early history of the Placer County iron deposit is interesting. It was first noticed in 1854 by Mr. S. W. Lovell, then President of the Bear River Water and Mining Company. It was located two thirds in the name of Caleb T. Fay, and the other third for John Bell. In J. Ross Browne's report, published at Washington in 1868, considerable space is given to it, and the attention of capitalists called to its importance. Arrangements had been made at that time with Coffee, Risdon & Co., to erect a furnace to test the ore; the plan, however, was never carried out. Mr. P. Fitzhue came up in 1874 to examine the deposit, attracted by the report of Professor Whitney in the volume of General Geology of California, one example of many known to the writer of the practical utility of the State Geological Survey. A company was incorporated, known as the "Iron Mountain Iron Company." The names of Judge Meyers, J. R. Brown, George Applegate, Charles Robinson, and A. C. Neil, appearing as incorporators. The property came into the possession of the present owners in the Winter of 1879-80.

A blast furnace consists essentially of two parts. The boshes and the cone, which combined form the column, the full height of which is forty-seven feet. The widest part of the interior diameter is ten feet. The minute details are technical and cannot be correctly described by one who is not familiar with them. The weight of the upper part of the furnace is supported by massive columns of cast iron. The exterior is of iron lined with fire brick.

From a point near the top, a large boiler-iron pipe called a "down-comer," conveys the gases generated in the furnace downward to the hot blast, and to the chamber under the boilers. Gravity doors, or "explosion doors," as they are called, are placed at frequent intervals, which open harmlessly and prevent damage. This is an extremely ingenious contrivance, without which it would be impossible to use the furnace gases, found by experience to be both convenient and economical. The gases are brought down to the hot blast and boilers by the natural draught of tall chimneys 100 feet high. The hot blast arrangement consists of a combustion chamber of 700 cubic feet capacity, in which fifty-six tons of iron pipe are coiled, through which 4,000 cubic feet of air per minute is forced by a compound blowing engine driven by a 125-horse power steam engine. The fuel used is wholly the product of the furnace, brought down by the down-comer, and burned under the boilers and in the combustion chamber, being regulated by the admission of atmospheric air through a graduated aperture, the management of which requires much skill and experience. As explosive mixtures of gas and air are frequently formed, the before mentioned explosion doors are a necessity. The temperature of the air is readily brought to from 800° to 1,200° at pleasure. At either temperature the pipes are cherry red.

There are five tuyeres entering the furnace at the base of the boshes, through which the powerful red hot blast is forced beneath the burning charcoal. This blast is kept up (except at short intervals, while casting,) night and day, as long as the furnace runs.

A small handy engine of thirty-horse power does the little chores about the place, the most important of which is the driving, at intervals, of an Eclipse rock-breaker, for reducing the size of the lumps of ore and limestone.

The upper part of the furnace is circled by a balustrade of boiler iron, forming an elevated platform above the roofs of the surrounding buildings, like a castle with battlements, open to the air in all weather, any rainfall being rendered harmless by the great heat. To this level the food of the monster is hoisted. In the center of this charmed circle ton upon ton of iron ore, and bushels of charcoal, are cast, at short intervals, into an insatiable mouth, in a succession of carefully weighed charges. The mouth is closed by a conical cover, shutting upwards from within, and held in place by a movable lever, which is nearly balanced at the outer end by a weight. When the charge is thrown upon the cover it slowly sinks, and the coal and iron fall into the furnace, down the conical sides of the "bell," as it is technically called. The weight at the end of the lever immediately brings it to its place, the only escape from the furnace being an angry puff of black smoke and an ebon cloud of charcoal dust. This operation, intended to be automatic, is assisted, at times, by a workman, who gently lifts or lowers the lever, as occasion may require.

The whole furnace is surrounded by an atmosphere of heated air—not unbearable, but tropical above the fervency of the Summer sun. There are two pipes towering high above the platform, at the end of which a magnificent column of flame, fifteen feet or more in height, rises like the beacon light of Pharos, illuminating at night the dark forest and the little village—a glorified gas-burner of gigantic proportions, worth a long journey to see. It has a golden-yellow color, with a tinge of purple, the latter caused, with scarcely a doubt, by the potassium in the fuel. The effect of this almost monochromatic light on the faces of those on the platform, and on the dusky foliage, is wierd and strange. Each face is ghastly and deathlike, while the night landscape is painted in India ink; all color being degraded by the unearthly light.

While looking at the busy workmen feeding the furnace, and scanning the mezzo-tinted landscape, the writer noticed a cloud of light-colored objects drawn toward the gigantic candle, which examination showed to be insects, fascinated, as well they might be, by the glorious lamp, and flying in resistless fanaticism to certain destruction. Countless thousands of silly moths, beetles, and night insects of many species and kind, rush in a painted cloud to a fiery death, and carpet the floor of the airy scaffold with their scorched bodies.

A large wire is introduced at intervals into the furnace through a small hole in the bell, by means of which the condition and position of the ore is ascertained.

The Balance Elevator, an invention of Mr. White, is an ingenious device for raising the ore, charcoal, fluxes, etc., to the top of the furnace, where they are fed into the hopper, and gradually, under the effect of their weight and the fire, sink to the outlet, from which the liquid iron issues at the command of the founder.

This elevator is simply two platforms suspended by a wire rope which passes over an iron pully under the control of a brake. Under each platform or cage is a tank furnished with a valve which opens mechanically when the platform reaches the bottom. Into the upper one, water is let in from a capacious faucet or valve connected with a large tank placed at a slight elevation. When the weight of the water is greater than the load, the upper platform begins to sink and the load to rise, the velocity of which is controlled by the brake.

The charges are weighed on a platform scale, the charcoal in a large van on wheels, and the limestone and ore jointly in a smaller car. They are raised on the balance elevator to the top, the ore having been first coarsely pulverized and the charcoal sifted. One charge, equal to thirty bushels of charcoal, is fed into the furnace every twenty minutes. The charge of iron is regulated by the accidental quality of the charcoal, the average being 800 pounds. The floor at the base of the furnace upon which the casting is made is about fifty feet square; it is divided into two equal parts, each side being used alternately. While the cast iron is cooling on one side molds are being prepared on the other. The whole floor is covered deeply with sand hauled from Bear River; being tailings from quartz mills, it is nearly pure quartz sand. The floor has a slight incline from the furnace. A shallow canal of damp sand is formed down the gentle slope from the furnace outlet. At right angles from the main canal, at intervals of about six feet, there are secondary canals or channels from which the ingot molds, also of sand, branch off. This arrangement may be likened to a comb of which the back is the secondary channel and the teeth the molds into which the liquid iron finally settles, forming rough ingots, or "pigs," the name by which they are generally known.

One side of the floor is covered with these combs, each at a lower level, to admit of the artificial lava stream filling them in succession, by natural gravity. When all is ready for a cast, the men take their stations, and the founder taps the furnace by cutting out a clay plug with a crowbar. Presently a glowing stream rushes forth and is guided by the workmen into the first set of sand molds. When this is full, an iron gate is so placed as to cut off the stream, which is coaxed into the next set, and so on until the whole casting is disposed of and the lower part of the furnace is empty. The blast is then stopped, and a new clay plug inserted. The blast is then continued and the work goes on as before. While the furnace is being drawn off the whole upper part is filled with charcoal, limestone, and iron ore, in an unfinished state. The writer saw a casting made at night, and it was a rare sight. The interior was illumined by the red hot iron. The workmen moved to and fro in the lurid light, quietly directing the flow of the lava stream into its arenaceous bed. It was a scene of unusual interest, and a striking illustration of the power of mind over matter.

Twenty-five tons of metallic iron, more or less, are cast every twenty-four hours. The metal is claimed to be of excellent quality, superior to any imported. The first cast was made April

24, 1881, at 4 o'clock A. M. One pig from this cast has been sent to the State Museum, where it will ever remain a historical memento of the inauguration of one of the most important mineral interests of California. At the date of the visit of the writer, 450 tons of iron had been produced without accident or serious impediment, 150 tons had been hauled to Clipper Gap and shipped to San Francisco. The average load by wagon to Clipper Gap was two tons, drawn by four horses, assisted at certain points by an extra span. The average weight of a pig is eighty pounds.

The slag is drawn off every three hours and the metal cast seven times each twenty-four hours. The smelting operation is continuous. When the furnace is once fired up the work is continued day and night for as long a time as possible—sometimes for two years. When the furnace is "blown out," or for any reason the work is discontinued, it is a costly operation which necessitates a partial reconstruction, for which reason it is economy to continue the run as long as possible.

Twenty charcoal ovens, or kilns, are required to supply this Moloch with fuel. They are built of brick, twenty-eight feet high, and about the same diameter; six of them are on the banks of Bear River, two miles from the furnace, and the others at a greater distance. Seven thousand acres of land have been secured by the company to insure a sufficiency of wood and charcoal, and to embrace an area of supposed undiscovered deposits of iron. There is stored in a capacious shed 100,000 bushels of charcoal, laid up to guard against deficiency, and all the kilns are kept at work making more. It was noticed by the writer that a vast amount of pyroligneous acid was going to waste, as were other products of the destructive distillation of wood, which it is hoped will be utilized in the near future.

By a fortunate circumstance a large deposit of limestone has been discovered within a few hundred feet of the furnace, from which an unlimited supply of that essential flux can be obtained, and its value as a flux is not in the least impaired by the fact that it is also a beautiful, white, saccharoidal marble, suited for ornamental and building purposes. A fine block has been placed in the Mining Bureau, which will be cut and polished to test its quality. It seems almost a shame to see such marble cast into the fiery furnace, martyr-like, in its beauty and purity. This marble has been largely sent to San Francisco, to be used in the manufacture of mineral waters. It can be quarried in large blocks if required. Other deposits of iron ore are continually being found, and a system of prospecting is wisely continued, that an unlimited supply of ore may be mined in advance of the demands of the furnace.

A second large deposit of limonite near Clipper Gap, discovered in 1863 by J. R. Browne, remains untouched. When last seen by the writer it showed a face in an open cut sixty feet long and twenty-five feet high.

Seventy-five men are employed, exclusive of those engaged as charcoal burners, teamsters, woodchoppers, limestone and iron miners, etc. The total number of men to whom employment is given, is one hundred and fifty in Summer and four hundred and fifty in Winter.

As the visitor looks forth from the iron battlements and views the surrounding plant, and the busy workmen at the base of the tower upon which he stands, or descends to the sandy floor and watches the streams of molten iron flowing obedient to the will of the iron founder, he not only sees the useful metal divorced at last from its ancient companion, oxygen, but also mentally pictures the future result of the enterprise so successfully inaugurated. The sluggish stream, slowly forming itself into rough pigs, is the precursor of other iron industries yet to be established, such as the manufacture of California steel rails for future railroads, steam engines, rolling mills, iron ships, mining machinery and tools, great guns for the defense of our coast, Bessemer converters, and countless articles of iron made in California workshops, giving employment to our own citizens. The ubiquitous hoodlum disappears, and his place is filled by the busy nail-cutter and the industrious mechanic of the future, proud to earn an honest living, and bringing up his happy family in comfort, who is not ashamed of his hard hands and grimy face, and is reckoned among the respected citizens of a prosperous State.

This picture does not require the aid of a vivid imagination, but naturally follows as a matter of course.

The California Iron Company has been succeeded by the California Iron and Steel Company. The new company, though composed mainly of the members of the old, have greatly enlarged the plans and purposes of their predecessors, it being their intention to enter extensively into the manufacture of bar and plate iron, steel rails, etc., as well as carry on the business of making pig metal. To this end they have not only purchased the entire estate of the old company, consisting of their ore beds, furnace, charcoal kilns, wood lands, roads, ditches, etc., but have projected large establishments, some of which are already completed, for carrying out the above objects.

While constructing these new works the company's smelter was kept in full blast up to the time of its partial destruction by fire, in the month of September, causing a temporary interruption of this branch of their business. With these multiplied and enlarged aims, it will become necessary for the company to increase the capacity of their smelting works, a measure that will meet with early consummation, and which, when carried out, must have the effect to largely curtail the importation of pig metal thereafter. With the product of the Washington and Oregon furnaces it is even probable that the importation of this staple will, in the course of a few years, cease altogether, with the exception of such small quantities of Scotch pig as are required for admixture with our home made iron. Meantime, extensive rolling mills will be put up at some eligible site, probably in the city, or at some point on the Bay of San Francisco, the nail factory, that forms a part of this project, being already finished and fully equipped for active service. This establishment, which consists of seven large buildings, having a floor-room of nearly 53,000 square feet, is located in West Oakland, on the line of the Central Pacific Railroad. Besides nails of various kinds, files, tacks, brads, hardware, and many other articles composed of iron will be manufactured here. This company is made up of successful, practical men, each member being peculiarly fitted, by experience and natural qualifications, for looking after some particular branch of the business they have undertaken. They are all men of large wealth, and at the same time active workers—men who earn and execute as well as think and plan. The cash investment made by the members of the California Iron and Steel Company on account of the Clipper Gap estate alone, approximates half a million dollars, their disbursements elsewhere having been very considerable. As their sagacity in divining the future of the State has rarely ever been at fault, these heavy ventures may be construed into omens favorable to our industrial future.

CALIFORNIA IRON ORES IN THE STATE MUSEUM.

[The numbers refer to the catalogue.]

CALIFORNIA.

1861. Hematite, Ochrous—Clipper Gap Iron Mine, section 24, township 13 north, range 8 east, Mount Diablo meridian, Placer County.

3585. Magnetite—Near the New England Mills, Placer County.

1333. Magnetite, in dodecahedral crystals—Six miles from Auburn, Placer County.

3361. Hematite and Magnetite—Near Crescent Mills, Plumas County.

3756. Magnetite—Mohawk Valley, Sierra County.

1712. Iron Ore, Oxide—Average from tunnel, Iron Mountain Mine, seven miles from Shasta, Shasta County.

1873. Magnetite—Iron Mountain, Shasta County.

20. Magnetite—McCloud River, Shasta County.

3422. Jaspery Iron Ore—Northwest corner of Sonoma County, near Point Arena.

3759. Magnetite—San Bernardino County; six miles from water.

2886. Magnetite—Eight or nine miles north of Mesquite Station, San Diego County.

1552. Limonite or Hematite—Harrington Iron Mine, San Luis Obispo County, California. four miles southwest of the city of San Luis Obispo, on subdivision of the Rancho Canada De Los Osos, township 31 south, ranges 11 and 12 east, Mount Diablo meridian. The ledge has a northwesterly direction, with a dip to the west. Supply of ore seemingly inexhaustible. An assay has been made showing eighty-five per cent. of iron.

3762. Iron Ore, Limonite—San Luis Obispo County.

3774. Iron Ore, Limonite—Twenty-five miles east of Visalia, Tulare County.

1519. Black Sand—Concentration from hydraulic washing, Hopland, Mendocino County.

3639. Iron Ore, Magnetite—Solid Iron Mine, Indian District, Mono County.

3768. Iron Ore, Magnetite—Near Benton, Mono County.

3757. Magnetite—Near St. Helena, Napa County.

3758. Metallic Iron, reduced from magnetite found near St. Helena, Napa County.

3773. Iron Ore, Hematite—Holden Ledge, township 15 north, range 7 east, Mount Diablo meridian, Nevada County.

3767. Iron Ore, Magnetite—Grass Valley, Nevada County.
2397. Limonite Concretions—Forest Hill, Placer County.
1937. Hematite—From Red Hill, section 15, township 13 north, range 8 east, Mount Diablo meridian, Placer County.
1938. Magnetite—Section 15, township 13 north, range 8 east, Mount Diablo meridian, Placer County.
2848. Pig of Cast Iron—From the first cast made by the California Iron Company, Sunday, April 23, 1881. Works at Clipper Gap, Placer County.
4019. Iron Buttons—Obtained in crucibles, from the Campo Seco iron ore, Calaveras County.
3760. Iron Ore, Limonite, and Hematite—San Andreas, Calaveras County.
4058. Iron Ore—Said to occur in large quantities one mile northeast of Sperry's hotel, Murphys, Calaveras County. It lies between limestone and slate. Plenty of wood and water.
1896. Hematite—Occurs in the rock formation, Kelsey Tunnel, fourteen miles southeast of Crescent City, Del Norte County.
965. Magnetite—El Dorado County, California, two miles northwest of Shingle Springs.
3712. Siderite, Carbonate of Iron—Tejunga Cañon, Los Angeles County.
4148. Iron Ore, Limonite—Near Latrobe, El Dorado County. Vein twenty-two feet wide. Plenty of wood and water. Metallic Iron, 55.41 per cent.
1996. Magnetite—Coulterville, Mariposa County.
3717. Limonite, after Pyrite, perfect crystals—Chowchilla Valley, Mariposa County.
3005. Magnetite—Base of Mount Hoffman, south side of the dividing ridge between Mariposa and Tuolumne Counties.
3006. Magnetite in Gangue—Base of Mount Hoffman.
1673. Magnetic Sand with Pyrites—Hydraulic washings, two miles northeast of Jackson, Amador County.
87. Hematite—Ione Valley, Amador County.
3750. Nodule of Hematite—Near Volcano, Amador County.
2833. Earthy Hematite—Monitor, Alpine County.
2336. Hematite—Alameda County.
2788. Iron Ore, Magnetite—Oroville, Butte County.
2285. Micaceous Iron, Hematite—Feather River, near Oroville, Butte County.
3763. Iron Ore, Limonite—Iron Monarch mine, township 4 north, range 10 east, Mount Diablo meridian, opposite section 3, in unsurveyed land, two miles in a southerly direction from Campo Seco, Calaveras County.
3766. Iron Ore, Hematite—Big Tree Iron mine, Calaveras County.
2455. Iron Ore, Limonite—Between Jenny Lind and Campo Seco, Calaveras County.
2745. Impure Red Ochre—McPherson's claim, Sheep Ranch district, Calaveras County.
4010. Yellow Ochre, Limonite—Found in considerable quantities adjoining an iron mine, Campo Seco township, near Campo Seco, Calaveras County. Valuable as a pigment.
4011. Burnt Ochre (same as No. 4010)—Near Campo Seco, Calaveras County.

OREGON.

108. Ironstone Concretion—Sixes River, Curry County.
3435. Pig Iron—Oregon Iron Company, Oswego, Clackamas County.
3436. Iron Ore, Prosser Iron Ore—Oregon Iron Company.
2354. Cast Iron—From the first pig cast in Oregon and probably the first on the Pacific Coast.

WASHINGTON TERRITORY.

2405. Limonite Impure—Twenty miles from Spokane Falls and thirty miles from Pyramid Lake.
3771. Iron Ore Hematite—Chinicum mine, Port Townsend Bay.
4059. Iron Ore—Skaggett River. This mineral seems to be a mixture of limonite and magnetite. It gives water in a glass tube and is strongly magnetic, only partly soluble in acids. Said to occur in large quantities with coal and limestone.

FOREIGN.

3769. Iron Ore Magnetite—Compact variety. Texada Island, Straits of Georgia, British Columbia.
3770. Iron Ore Magnetite—Cellular variety. Texada Island, Straits of Georgia, British Columbia.
3672. Pig Iron—First run on ores from Taxada Island iron mines, British Columbia.
3599. Iron Ore with Fossils—Found with 3598, shores of the Arctic Ocean.

SUNDRY.

1716. Limonite after Pyrite—Cherry Creek District, Yavapai County, Arizona.
1790. Micaceous Hematite—Near White Plains, Churchill County, Nevada, said to occur in large quantities.

LUMBER AND FUEL.

Lumber and timber are extensively used for mining purposes in California. In fact they are indispensable to the successful working of mines, and were it not that forest trees are abundant and forests extensive in the State, the cost of mining would be greatly increased by the necessity of bringing wood from afar. The uses of wood in mining are almost innumerable, but the mention of a few of the most important will convey to the minds of those who are unfamiliar with the subject the importance of forest trees and their products to the mining interests of the State. Timbers and lagging, for tunnels and shafts, derrick-masts, water-wheels, flumes, pressure-boxes, bridges, houses and sheds, mills, hoisting-works, tramway tracks and cars, paving blocks for flumes, penstocks, pick and tool handles, water and pulp tanks, salt pans, furniture and minor machinery, boats, and fuel, including charcoal.

As timber, both for lumber and fuel, constitutes, in all mining operations, an important factor, some remarks touching its present and future sources of supply, modes of transportation and use, may not here be out of place. At the outset it may be stated that, in so far as home wants are concerned, there is little danger of our mining interests suffering from lack of timber, for whatever purpose it may be required. Almost the entire mining region of California is not only well wooded, in the common acceptation of the term, but it is heavily timbered with trees of the very best kind for the manufacture of every form of timber, to say nothing of terebinthine forests and woods suitable for burning into charcoal. Except only the northeastern and southeastern corners of the State, with some portions of the trans-Sierra, the mining districts of California could never be without cheap lumber and fuel, were they the only consumers, since, cut away the forests as we will, the new growth would more than suffice to keep good the supply, so far as local requirements are concerned. The danger of unduly depleting our stock, if any there be, arises out of the heavy drain likely to be made upon it by our neighbors to the south and east. The country lying between the Sierra Nevada and the Wasatch Mountains, nearly a thousand miles across, is a timberless, almost treeless region; but it abounds in valuable deposits of gold, silver, and copper—the working of which will create vast necessities for fuel and lumber, nearly the whole of which will have to be obtained inside the lines of this State. Eastern Utah, with railroads reaching into the forests of Colorado and Montana, may thence supply her wants in part, but not wholly, as these forests furnish little or no first-class lumber. For this she will have to come, as heretofore, to California.

THE DRAFTS ALREADY MADE ON OUR TIMBER PRESERVES.

Before proceeding with this branch of our subject, it may be premised that by a law of Congress, enacted June 3, 1878, the inhabitants of the public mineral domain are permitted to cut and use the timber growing thereon for domestic and mining purposes; being only restrained from cutting the smaller trees and from committing any unnecessary waste. Construing this law to mean that such inhabitants were to be allowed to cut only what timber they required for their private and individual use, certain government officials proceeded, several years since, to institute suits against such of them as they found engaged in making lumber and cutting fuel on contract or for sale to other parties. As this view of the law was sustained by the then Secretary of the Interior, some annoyance was, for the time being, caused to this class of lumbermen and woodchoppers, notwithstanding the rulings of the Secretary were pretty generally disregarded. The present Secretary of the Interior having reversed the findings of his predecessor, the inhabitants on the public mineral domain are now free, within the restrictions fixed by law, to cut timber to an unlimited extent, whether the same be for their personal use or for market.

Whether or not we have reason for anxiety about our future timber supply, will be made more apparent if we examine for a moment the inroads already made upon our forests, the probable extent of future demands, and our means for meeting them. During the past twenty years the mines on the Comstock lode alone have absorbed over one thousand million feet of lumber, the country extending from the Sierra Nevada to the Wasatch range having meantime used as much more. Besides this lumber, vast quantities of cordwood have been consumed by these Comstock mines, more than two thirds of which, with fully one half of the lumber mentioned, has been cut on California territory. While the lumber and fuel requirements for the Comstock mines are not now so large as formerly, and will probably never again assume their former dimensions, the demands for the Great Basin country to the east are just commencing, and must in the course of a few years reach very large proportions. These demands must be met for the most part by the products of our California forests, the comparatively narrow strip of timber on the Nevada side of the line being now nearly exhausted. If we assume that seventy million feet of lumber, besides much cordwood, will from this time on be required annually for the country mentioned, the Comstock mines included, we shall be clearly within the bounds of probability. To fully represent this easterly flowing drain upon our woodlands along the further slope of the Sierra Nevadas, there must to the foregoing be added local consumption, amounting to several million feet more.

Now, to those unacquainted with the character of the forests growing on the Sierra Nevada, it would be thought that a large area of these mountain woodlands must already have been denuded of their timber. But such is not the case. Along the easterly face of that portion of the range that lies within the State of Nevada the timber has been mostly cut away. But this, as before remarked, is only a narrow belt. The trees, too, that grew here were small, as compared with those further up the mountain, the lumber made from them being also of inferior quality. The encroachments made upon the California forests adjacent on the west are barely perceptible, notwithstanding they contributed so largely towards making up this 2,000,000,000 feet of lumber. Except in the basin of the Truckee and about the shores of Lake Tahoe, these woods have been but little despoiled by the ax of the lumberman. They stand almost untouched in their original grandeur, the great trees attaining a height of two hundred feet or more, a hundred feet often without knot or limb. In the localities mentioned, and extending over an area of perhaps 20,000 acres, the trees have been pretty well thinned out, the largest and best being cut away. But there still remains, lying wholly to the east of the main summit of the Sierra, several million acres of primeval forests but little invaded, and all as stately as above described. As these lands, when stripped of their first crop of timber, never fail to replant themselves, the new growth advancing with great rapidity, it is evident that the question of timber supply is one about which we need have little anxiety, if only our resources in that direction shall receive careful husbandry.

Some statisticians, figuring on this question with reference to the prospective wants of Utah and Nevada, have estimated that there is timber enough along the "Eastern Slope," between Hope Valley and Beckworth Pass, a region outletting east via the Central Pacific Railroad, to make 5,000,000,000 feet of lumber, and 10,000,000 cords of firewood; enough to save these two States from any timber strait for the next fifty years or more.

Touching the reproductive powers of these timber lands, it should be observed, that their energies in this direction manifest themselves in diminished force as we go east from the main crest of the Sierra Nevada, being much weaker on the eastern than on the summit and along the western slope of these mountains. In these latter localities, immediately the original forest is cut away or much thinned out, the growing trees spring up everywhere, and shoot ahead rapidly; whereas, once fairly over the summit, a difference begins to be seen; the second crop, as we reach lower altitudes, being smaller, more scattered, and of much slower growth—differences due to a poorer soil, increased aridity, and other climatic changes. But notwithstanding the forests along the border lands of the two States renew themselves somewhat slowly, the danger of any early shortening of the timber supply even there can in no sense be considered impending.

Of the stunted forests that sparsely cover some portions of the Nevada mountains, it is hardly worth while to speak in considering the lumber resources of that State. These forests, which consist mainly of the nut pine, pinyon, and juniper, furnish in considerable quantity an excellent fuel; the pinyon being a solid, resinous wood, that burns long, emits much heat, and makes an excellent charcoal. But for lumber these trees, other than affording a short, indifferent post, and sometimes a small, knotty saw log, are of little account. A twelve foot board, made from one of these logs, besides being rough and knotty, possesses such a power of torsion, that it nearly ties itself into a knot in the process of drying. At a few spots in these mountains occur small groves of white pine. But these trees, though larger than the pinyon, afford but little clear stuff, being full of limbs, and never turning out more than two short saw logs to the tree. This pine being soft and brittle, is fit only for the most common kinds of work. These Nevada forests are all of slow growth, it taking a century or more for one of these scrubby trees to reach maturity. For all practical purposes, therefore, these forests may be said not to reproduce themselves at all.

COAST COUNTY FORESTS.

As we have wood enough in the mineral regions to meet all the requirements growing out of mining operations, little need be said here about the timber lands situate elsewhere in the State, as it is not at all likely that we shall ever have to draw upon them for mining purposes.

From the redwood belt and other forests along or near the sea coast, San Francisco, and much of the State besides, will obtain most of their lumber. From these sources also will continue to come a large portion of that shipped to foreign markets, the stock of timber here being immense, and the quality very superior. The quantity of lumber made in some of these northern coast counties is enormous, that turned out in Humboldt alone amounting last year to over 40,000,000 cubic feet.

The exports of lumber for the year 1881 exceeded 18,000,000 feet. Of these exports England took nearly 7,000,000 feet, Mexico over 4,000,000, the Hawaiian Islands and Australia also taking large quantities, the balance being distributed in smaller shipments to many other countries. Lumber, by reason of the large size of the trees, and the large amount of clear stuff they afford, can be made cheaper, and of better quality, in this part of California, than in any other portion of the coast, or perhaps in the world, notwithstanding extreme high wages are paid to workmen. The quantity of lumber taken from an acre of these redwood lands would surprise those whose experience has been confined to lumbering in the Eastern States. In Maine it is considered a good acre that turns off 18,000 to 20,000 feet of marketable lumber, whereas, as much as 2,000,000 feet has been taken from a like area of the California redwoods, 1,000,000 feet per acre being by no means an extraordinary yield. Single trees here frequently make from 60,000 to 75,000 feet of good lumber. In these redwoods the trees range from 200 to 300 feet in height, and stand so close together that it is often difficult to drive a wagon between them, notwithstanding there is no undergrowth in these forests. Some of these trees are twenty feet across at the base, their average diameter at the butt being from six to eight feet. With such timber to deal with, the lumbermen in this part of California have nothing to fear from competition.

LUMBER FLUMES.

While the business of getting the logs to the mills, and the manufactured lumber to shipping points, is, in these forests along the coast, simple and easy enough, being effected by means of wagons, railroads, and water carriage, this transportation service in the mountains becomes one of greater difficulty, owing to the rugged character of the country, and the long distances that usually intervene between the timber lands and the points of lumber and fuel consumption. For the purpose of overcoming these obstacles, recourse has, in many instances, been had to the construction of flumes, which, wherever tried, have well answered the end in view. While these structures are all built on the same general plan, they differ much in size, length, and cost of construction, some traversing a very rough, while others run through a comparatively smooth and level country. These flumes are simply long wooden races, consisting, generally, of two broad, heavy planks, joined together at their lower edges, and flaring out, upwards, in the form of the letter V, gaining for them often the name of V flumes. These planks are supported by side pieces, the whole structure resting on solid block foundations, trestleworks being employed for their support where depressions and ravines are to be crossed. These trestleworks are sometimes many miles long, and very lofty, in places as much as a hundred feet or more in height. The V flume is maintained throughout on an even grade, having just sufficient descent to impart a rapid flow to the water when filled. In laying it down, curves are avoided so far as possible, none of very short radius being admissible. The flume being completed, water from a neighboring stream—sometimes that used to drive the mill that cuts the lumber—is let in at the head, filling the race to within a few inches of the top. The carrying capacity of these flumes depends, of course, upon their size, which varies from twenty to thirty inches across the top, even the smallest being large enough to float a good sized plank, or a log a foot or more through. Besides logs and sawed lumber, posts, poles, firewood, laths, shingles, and mining timbers are passed through them. A twenty-inch flume, having a three-mile current per hour, is capable of delivering at its mouth, or at any point along its length, 230,000 feet of lumber daily, a long flume being able to transport just as much as a short one. The lumber, once committed to the current, unless too heavy for the body of water, or sharp curves occur in the flume, is apt to pass along without stopping. The transmission of material down these races, unlike wood and log drives on the rivers, requires very little looking after.

DRY FLUMES AND LOG WAYS.

Where the ground is too rocky, steep, or otherwise unsuitable for the construction of water-filled flumes, troughs or chutes, made from heavy timbers, are laid down at an angle sufficiently high to carry the wood and lumber along them without the aid of water. These chutes are straight, and usually extend only from the top to the bottom of a single hill, or other continuous descent. In places, where the ground is steep and large logs are to be sent down, two lines of heavy timber laid near each other are fixed firmly in the surface of the ground, and the trees slid down this track. Such is the friction, caused by the passage of sticks down these log ways, that they leave a trail of smoke, and sometimes even fire, behind them. When sent down in this manner, the logs require to be shot into a lake or other deep water to prevent their ends being so bruised and shattered as to greatly depreciate their value for lumber.

Along the sea coast, where the shores are steep and high, lumber vessels are sometimes loaded by means of chutes, being long troughs or races built of strong timbers and set at such an angle that lumber placed in them slides down by its own gravity. These chutes, some of which are several hundred feet long, greatly diminish the danger and cost of loading vessels at such points; a work that very often, in fact, could not be done without them, owing to the dangers of the coast, in any but the calmest weather.

UTILITY, SITES, AND COST OF THE V FLUMES.

The principal sites of the V flumes are in the basin of the Truckee and along the easterly and westerly slopes of the Sierra Nevada and their outlying foothills, there being a few also in other sections of the country. In length these structures vary from ten to thirty miles, and in cost from two to ten thousand dollars per mile. The longest yet built is that of the Sierra Lumber Company, extending from the town of Chico east thirty miles into the timber lands along the base of the mountains. The largest and most costly is that belonging to the Bonanza firm, built for bringing down fuel and lumber from the easterly slope of the Sierra into Washoe Valley, whence they are conveyed by rail to Virginia City. This flume is fifteen miles long, and cost, on an average, $10,000 per mile, a good deal of it resting on lofty trestlework. The Prosser Creek flume in the Truckee basin, though not over seven miles long, cost $27,000; most of the other flumes in that vicinity, of which there are several, having cost at a like rate. The flume built in 1874 for supplying Grass Valley and Nevada City with lumber and fuel, cost but $2,000 per mile, the country traversed by it being nearly level and free from any formidable obstructions.

The building of these races, by facilitating the transportation of lumber and fuel to points where required for use, has prevented the prices of these articles being advanced, as they otherwise would necessarily have been, to enormous figures. Through their agency too it has been possible, in many instances, to locate sawmills, on or near the line of the railroad, the logs through these races being conveyed at a tithe of what it would cost to bring them in from the steep mountain sides on wagons.

TIMBER FRAMERS.

After the timbers for supporting the mines have been sawed of the proper size and brought upon the ground, there still remains the labor of framing and properly fitting them to be put in place. For the more ready and accurate performance of this work steam-driven machines have come to be employed for cutting the tenons on the ends of these timbers. These machines are provided with a cutter-head rotating on a frame, which latter is moved both vertically and horizontally by means of slides and guides that carry the cutter across the timbers, either upon one or all sides, as may be desired, a tenon, square, cylindrical, or dovetailed, being cut with the utmost accuracy and in an incredibly short time. By an attachment to this device mortises can be readily made in the sides or ends of the timbers of the depth and form required. A machine of this kind is now in use at most of the larger mines.

For a scientific description of the principal forest trees of California the reader is referred to the paper by Dr. A. Kellogg, an appendix to this report.

SAWMILLS.

The typical mountain sawmill is located in some convenient valley, to which a small stream of water is conveyed by ditch or flume, for the use of the engine. The mill is covered by a roof of rough boards, while the sides are open. The building is generally constructed after the engine and saws are set, the boards being cut by the mill, and the house built over the machinery. The mill is generally, if not always, driven by a common steam engine of sufficient power. The saws, which are circular, with movable teeth, are set over each other and run in the same plane, the teeth of the lower one cutting downward while those of the upper cut upwards. This arrangement causes the sawdust to clear the saws.

The road along which the logs are hauled runs parallel with the length of the mill and the valley in which the mill is located. The mill carriage and saws run in the same direction. All the motions of the mill machinery are controlled by tightening pulleys moved by levers. One man, standing near the saws, has command of the entire machinery.

The logs are drawn to the mill and unloaded on a plane slightly inclined toward the log carriage. The incline is laid with heavy skids, buried even with the ground, down which the logs are rolled. The log carriage is moved by belts to the proper position, when a chain, with hook or dog, is fastened to the log. The chain is connected with a small iron shaft, to which great purchase is imparted by a large pulley, connected with the machinery of the mill and set in motion by a tightening pulley. By this the log is rolled with ease upon the carriage, which is a table of iron and wood, perfectly level and square, which runs on a tramway. Upon the upper face of the carriage there are two movable knees, set parallel with the saws, and movable by a pair of screws, furnished with hand wheels. When the screws are turned, the log is pushed forward toward the plane of the saws, on the accurately planed carriage bed. When it is required to move both knees equally, the hand wheels are connected by a strong strip of plank, like the connecting rod of a locomotive engine. When it is required to move the knees back for a new log, a jointed nut is opened by a lever, which disconnects it from the screw. When the lever is again depressed the nut closes on the screw. On the iron slides on which these knees move, there is a graduated scale of inches and quarters, by which the man who runs the carriage can set the log exactly parallel to the saws. The log is under the most perfect control, and can be pushed forward or drawn back, at pleasure.

When all is ready the log is run up to the saws, and a few cuts made which furnish a few inferior boards, a slab, and a face on the log. The before mentioned chain is then hooked on, by which the log is quickly turned face downward, and the same operation repeated until a square heavy timber remains on the carriage. The man who has charge of the carriage then puts on the connecting rod, by means of which he turns both hand wheels equally. He turns the wheels as required, and according to the timber or plank to be cut—one turn for each quarter of an inch, and one for the cut of the saws; this is repeated until the whole log is cut into the required lumber. It is sometimes found convenient to cut the log into pieces, suitable size, called cants, which are ripped into boards and planks by a set of gang saws, running in a different part of the mill, but driven by the same machinery. The heart of the sugar pine is cut out and rejected, except for inferior lumber. When the lumber is cut it is piled on tramway cars, by which it is conveyed to the lumber yard, where it is carefully piled for drying. The sawdust falls through the mill on a secondary floor, from whence it is removed in cars and dumped in the cañon, to be washed away by the Winter floods.

The refuse lumber is more than sufficient to supply fuel for the boiler. At the end of the season the excess is burned and a general clean-up made. In the Winter all the men are discharged, and the work suspended, to be resumed again in the Spring.

The logs are drawn to the mill on trucks of peculiar construction. The wheels are sections of logs, like those of ancient chariots. The wood is first made perfectly dry, when six-inch extra heavy tire is burned on in the usual way. The center is bored and a heavy axle box inserted. The wood is then turned on the axle to the width of the tire, and from eighteen inches to two feet at the axle. When this immensely strong wheel shows signs of weakness from use, wedges of oak are driven into the soft wood of the wheel—generally sugar pine—until the tire is tight again.

The body of the truck is built of the heaviest and the hardest wood at hand, which is strengthened by heavy irons. On each heavy bolster over each pair of wheels is spiked a portion of a railroad steel rail, and at each end of each there is a strong ringbolt of iron and a stirrup, also, of iron, in which to place the end of a heavy iron shod skid, so arranged that the top of the skid will be level with the steel rail.

When it is required to load the logs, the truck is placed in proper position, the skids inclining toward the log and touching it, the upper ends being hooked securely in the iron stirrups. A heavy chain is then placed in the before mentioned ringbolts, passed under the log, and the bight brought over the log and across the truck. The oxen are unhitched from the truck, and hitched to the bight of the chain, when, being driven forward, the log is parbuckled up and rolled on the truck with the greatest ease. When the logs are comparatively small, five or six of them are loaded in this way, and driven to the mill. The log must be large, indeed, to be considered a whole load for one of these trucks.

Trees are all felled by sawing. As soon as the saw has cut its depth, steel wedges are driven in behind it, and redriven from time to time, as required, by which the tree is forced to fall in the direction required. When the saw is nearly through, a few cuts with an axe causes the tree to fall.

TURPENTINE AND ROSIN.

When, during the late civil war, our supply of turpentine and rosin began to fail, by reason of the embargo laid on their exportation from North Carolina, certain citizens of Butte County sought to make good the deficiency by manufacturing these articles from the yellow pine (*Pinus Ponderosa*), which grows so abundantly in that section of the State. To this end these trees were extensively tapped; deep notches, called boxes, with a downward and inward slant, having been cut into the sides of the tree for collecting and holding the sap, which latter flowed into these receptacles at the rate of eight or ten ounces each week. The tapping was done in the Spring, and it was found that each good sized tree yielded between three and four gallons the first season, with some slight increase for the next two or three years thereafter. Experience proved that the tree, if gashed on but two sides, received no immediate harm; if on three, it was apt to die; any further mutilation being sure to kill it in a very short time. This fluid pitch was distilled at Dogtown, produced a good article of both turpentine and rosin, of which enough for home consumption was made during the continuance of the war. With the restoration of peace, the exportation of these commodities from the old tar, pitch, and turpentine State having been resumed, the manufacture in California was discontinued.

In connection with this business, however, there grew up another which was destined to survive it. In experimenting with different trees to test their fitness for making turpentine, in the course of their experiments, these tree tappers having made trial of the nut pine (*Pinus Sabiniana*) as a turpentine producer, found that while its sap could not be converted into that article, it possessed properties that rendered it useful as a perfume and a detergent, for which purpose it has since come to be much sought after. This liquid, known under the various names of erasine, aurantine, theoline, abientine, and perhaps other equally novel appellations, is of less specific gravity than turpentine, and possesses a pleasant aromatic and slightly turpentine odor. The liquor is distilled from the pitch by the pharmacists, who buy it at the rate of about three cents per pound. The most of the raw material continues to be gathered in Butte County, though the manufacture is carried on both there and elsewhere; principally in the City of San Francisco. At the Butte Creek House, twenty-eight miles from Dogtown, Butte County, Mr. John Williams is extensively engaged in this manufacture, of which Perkins & Co., of Oroville, are agents.

The era of turpentine production in California extended from about the year 1862 to 1868, during which time the local supply amounted to about 30,000 gallons of this fluid and 3,000 cases of rosin annually, the quantities made being larger at first and declining towards the end of this period. The articles made were considered equal to the imported, and if manufacturers could secure the entire home market, enough of these commodities to supply all local demands could be made from the pineries of Butte County alone, though these form but a small part of the forests of this kind found elsewhere in the State.

The following statement of receipts of lumber at San Francisco for ten years has been furnished to the State Mining Bureau by the Lumber Dealers' Exchange:

Lumber—1872.	Feet.	Totals.
Redwood, rough	48,702,081	
Redwood, rough clear	4,711,578	
Redwood, dressed	30,676,081	
Redwood, dressed, half-inch	176,704	
Redwood, siding, half-inch	988,804	
Redwood, battens, half-inch	286,529	
Redwood, pickets, rough	1,253,467	
Redwood, pickets, dressed	556,501	
Redwood, railroad ties	6,243,294	
Redwood, telegraph poles	673,894	
		94,268,933
Pine, rough	103,103,066	
Pine, dressed	13,303,614	
Pine, fencing	10,201,283	
Pine, pickets	146,974	
		126,754,937
Spruce, rough	8,480,599	
Spruce, dressed	157,771	
		8,638,370
Cedar, rough		2,400,364
Hardwood		152,213
Total		232,214,817

SUNDRIES.

Shingles	56,864,000	Railroad ties, rift	388,142
Laths	25,181,500	Broom handles	185,726
Ship knees	402	Spanish cedar logs	5,037
Piles, lineal feet	411,905	Spars, pieces	34
Redwood posts	678,534	Poles, lineal feet	32,310

Lumber—1873.	Feet.	Totals.
Redwood, rough	38,797,676	
Redwood, rough clear	5,372,044	
Redwood, dressed	21,430,775	
Redwood, dressed, half-inch	188,654	
Redwood, siding, half-inch	690,728	
Redwood, battens, half-inch	209,223	
Redwood, pickets, rough	978,380	
Redwood, pickets, dressed	513,892	
Redwood, railroad ties	2,107,349	
Redwood, telegraph poles	333,392	
		70,622,113
Pine, rough	92,568,512	
Pine, dressed	12,805,566	
Pine, fencing	12,017,373	
Pine, pickets	48,553	
		117,420,004
Spruce, rough	7,793,197	
Spruce, dressed	342,274	
		8,135,471
Cedar, rough		2,262,333
Hardwood		146,410
Total		198,586,331

SUNDRIES.

Shingles	60,228,750	Broom handles	123,500
Laths	27,258,500	Spanish cedar logs	5,355
Ship knees	1,553	Primavera logs	44
Piles, lineal feet	542,253	Spars, lineal feet	3,875
Redwood posts	750,854	Poles, lineal feet	2,022
Railroad ties, rift	240,932		

Lumber—1874.	Feet.	Totals.
Redwood, rough	47,715,249	
Redwood, rough clear	5,122,217	
Redwood, dressed	33,473,409	
Redwood, dressed, half-inch	115,365	
Redwood, siding, half-inch	638,471	
Redwood, battens, half-inch	265,810	
Redwood, pickets, rough	1,262,405	
Redwood, pickets, dressed	616,567	
Redwood, railroad ties	2,558,614	
Redwood, telegraph poles	557,914	
		92,326,021
Pine, rough	109,960,737	
Pine, dressed	15,260,932	
Pine, fencing	14,419,775	
Pine, pickets	215,042	
		139,856,486
Spruce, rough	11,866,163	
Spruce, dressed	765,690	
		12,631,853
Cedar, rough		3,144,343
Hardwood		188,856
Total		248,147,559

SUNDRIES.

Shingles	70,413,250	Broom handles	397,863
Laths	42,229,100	Spanish cedar logs	9,070
Ship knees	2,048	Lignumvitæ logs	90
Piles, lineal feet	555,583	Primavera logs	837
Redwood posts	789,046	Spars, lineal feet	3,296
Railroad ties, rift	226,019	Poles, lineal feet	58,963

Lumber—1875.	Feet.	Totals.
Redwood, rough	56,795,106	
Redwood, rough clear	6,574,278	
Redwood, dressed	45,741,981	
Redwood, dressed, half-ineh	239,596	
Redwood, siding, half-inch	672,524	
Redwood, battens, half-inch	289,530	
Redwood, pickets, rough	1,160,006	
Redwood, pickets, dressed	604,110	
Redwood, railroad ties	3,399,211	
Redwood, telegraph poles	688,415	
		116,164,757
Pine, rough	130,829,672	
Pine, dressed	19,744,325	
Pine, fencing	12,778,500	
Pine, pickets	342,929	
		163,695,426
Spruce, rough	11,400,653	
Spruce, dressed	953,917	
		12,354,570
Cedar, rough		7,730,400
Hardwood		154,040
Total		300,099,193

SUNDRIES.

Shingles	104,930,000	Railroad ties, rift	405,447
Laths	56,006,500	Broom handles	577,354
Ship knees	2,096	Spanish cedar logs	6,779
Piles, lineal feet	593,287	Primavera logs	1,684
Redwood posts	598,905	Spars, lineal feet	3,543

LUMBER—1876.	Feet.	Total.
Redwood, rough	54,611,233	
Redwood, rough clear	8,855,294	
Redwood, dressed	49,300,538	
Redwood, dressed, half-inch	188,940	
Redwood, siding, half-inch	898,259	
Redwood, battens, half-inch	274,468	
Redwood, pickets, rough	1,156,670	
Redwood, pickets, dressed	379,986	
Redwood, railroad ties	108,004	
Redwood, telegraph poles	177,662	
		115,951,054
Pine, rough	125,258,520	
Pine, dressed	22,399,121	
Pine, fencing	13,307,703	
Pine, pickets	372,697	
		161,338,041
Spruce, rough	16,349,896	
Spruce, dressed	461,403	
		16,811,299
Cedar, rough		10,474,427
Hardwood		50,000
Total		304,624,821

SUNDRIES.

Shingles	**114,305,500**	**Broom handles**	**425,000**
Laths	**62,313,000**	**Wool slats**	**100,000**
Ship knees	**205**	**Spanish cedar logs**	**6,457**
Piles, lineal feet	**445,134**	**Toa logs**	**747**
Redwood posts	**807,474**	**Spars, lineal feet**	**7,313**
Railroad ties, rift	**821,003**	**Poles, lineal feet**	**880**

LUMBER—1877.	Feet.	Total.
Redwood, rough	49,325,786	
Redwood, rough clear	5,735,325	
Redwood, dressed	46,038,260	
Redwood, dressed, half-inch	159,460	
Redwood, siding, half-inch	321,399	
Redwood, battens, half-inch	282,845	
Redwood, pickets, rough	1,523,226	
Redwood, pickets, dressed	675,247	
Redwood, railroad ties	237,000	
Redwood, telegraph poles	172,000	
		104,470,548
Pine, rough	123,099,302	
Pine, dressed	20,894,976	
Pine, fencing	15,267,246	
Pine, pickets	481,029	
		159,742,553
Spruce, rough	9,312,277	
Spruce, dressed	359,171	
		9,671,448
Cedar, rough		5,940,973
Hardwood		67,000
Total		279,892,522

SUNDRIES.

Shingles	89,468,250	Wool slats	97,800
Laths	43,443,400	Spanish cedar logs	6,197
Ship knees	1,386	Lignumvitæ logs	46
Piles, lineal feet	519,093	Toa logs	408
Redwood posts	1,058,618	Primavera logs	227
Railroad ties, rift	836,256	Spars, lineal feet	4,690
Broom handles	272,584	Poles, lineal feet	1,000

Lumber—1878.	Feet.	Total.
Redwood, rough	50,426,529	
Redwood, rough clear	5,039,567	
Redwood, dressed	35,282,782	
Redwood, dressed, half-inch	136,971	
Redwood, siding, half-inch	572,374	
Redwood, battens, half-inch	391,497	
Redwood, pickets, rough	1,283,152	
Redwood, pickets, dressed	414,004	
		93,546,876
Pine, rough	119,905,372	
Pine, dressed	14,983,983	
Pine, fencing	12,994,876	
Pine, pickets	244,557	
		148,128,788
Spruce, rough	13,376,475	
Spruce, dressed	321,938	
		13,698,413
Cedar, rough		3,337,388
Total		258,711,465

SUNDRIES.

Shingles	37,292,500	Broom handles	297,502
Laths	35,233,700	Spanish cedar logs	5,775
Shakes	2,368,175	Lignumvitæ logs	50
Ship knees	827	Primavera logs	599
Piles, lineal feet	506,901	Spars, lineal feet	3,697
Redwood posts	750,359	Poles, lineal feet	5,810
Railroad ties, rift	225,591		

Lumber—1879.	Feet.	Total.
Redwood, rough	44,062,184	
Redwood, rough, clear	4,482,389	
Redwood, dressed	35,863,732	
Redwood, dressed, half-inch	189,673	
Redwood, siding, half-inch	238,314	
Redwood, battens, half-inch	263,701	
Redwood, pickets, rough	1,044,788	
Redwood, pickets, dressed	570,333	
Redwood, railroad ties	506,119	
Redwood, telegraph poles	182,496	
		87,493,729
Pine, rough	98,021,726	
Pine, dressed	14,171,278	
Pine, fencing	11,719,864	
Pine, pickets	380,179	
		124,293,047
Spruce, rough	13,716,906	
Spruce, dressed	328,078	
		14,044,984
Cedar, rough		1,128,487
Hardwood		125,046
Total		227,085,293

SUNDRIES.

Shingles	84,227,500	Broom handles	324,490
Laths	24,024,900	Spanish cedar logs	5,711
Shakes	4,685,225	Toa logs	993
Ship knees	653	Primavera logs	303
Piles, lineal feet	1,013,177	Spars, lineal feet	11,270
Redwood posts	628,981	Poles, lineal feet	90
Railroad ties, rift	308,913		

Lumber—1880.	Feet.	Total.
Redwood, rough	41,998,080	
Redwood, rough clear	5,073,024	
Redwood, dressed	31,348,497	
Redwood, dressed, half-inch	96,742	
Redwood, siding, half-inch	220,734	
Redwood, battens, half-inch	214,212	
Redwood, pickets, rough	903,942	
Redwood, pickets, dressed	384,188	
Redwood, railroad ties	109,337	
		80,348,756
Pine, rough	89,031,235	
Pine, dressed	14,784,671	
Pine, fencing	10,532,437	
Pine, pickets	42,640	
		114,390,983
Spruce, rough	16,314,481	
Spruce, dressed	651,927	
		16,966,408
Cedar, rough		2,399,023
Hardwood		280,195
Total		214,385,365

SUNDRIES.

Shingles	124,741,750	Railroad ties, rift	449,907
Laths	26,124,900	Broom handles	388,638
Shakes	6,708,750	Wool slats	266,425
Ship knees	694	Spanish cedar logs	8,725
Piles, lineal feet	519,350	Spars, pieces	213
Redwood posts	538,799		

Lumber—1881.	Feet.	Total.
Redwood, rough	47,950,849	
Redwood, rough clear	7,298,111	
Redwood, dressed	37,799,946	
Redwood, dressed, half-inch	68,776	
Redwood, siding, half-inch	320,369	
Redwood, battens, half-inch	292,023	
Redwood, pickets, rough	1,189,910	
Redwood, pickets, dressed	494,572	
		95,414,556
Pine, rough	106,759,374	
Pine, dressed	15,476,686	
Pine, fencing	8,288,012	
Pine, pickets	29,059	
		130,553,131
Spruce, rough	21,899,972	
Spruce, dressed	568,884	
		22,468,856
Cedar, rough		2,800,587
Hardwood		502,823
Total		251,739,953

SUNDRIES.

Shingles	150,264,750	Railroad ties, rift	1,206,009
Laths	32,467,600	Broom handles	550,675
Shakes	7,219,550	Spanish cedar logs	6,522
Ship knees	367	Spars, lineal feet	21,424
Piles, lineal feet	678,038	Poles, lineal feet	12,310
Redwood posts	470,494		

ON THE OCCURRENCE OF SALT IN CALIFORNIA AND ITS MANUFACTURE.

In my first report of progress to the Governor, in 1880, allusion was made to the salt interests of the State, attention called to certain salt springs discovered in Placer County, near the Clipper Gap iron mines, and some descriptions and statistics given, relating to the salt production of other States. This matter is so important and interesting that it was thought best to visit some of the most extensive deposits in the State, and give, with the description of them, certain general facts bearing on the subject.

Salt is extensively used as an article of food. It is well known that animals will risk their lives to obtain it. It is found in the blood and in some of the secretions, specially in perspiration and tears. From a single drop of the latter, salt may be crystallized out and readily distinguished under the microscope.

Hydrochloric acid forms an essential constituent of the gastric juice and soda of the blood, both of which are the result of decomposition of salt taken into the stomach in food.

In some diseases, as cholera, according to Dr. Stevens, as quoted by Perieira, there is a deficiency of saline matter in the blood. The same author quotes from a speech of Lord Somerville on agriculture, in which he alludes to "an ancient law in Holland which ordained men to be kept on bread alone, unmixed with salt, as the severest punishment that could be inflicted upon them. In their moist climate, the effect was horrible; these wretched criminals are said to have been devoured by worms engendered in their own stomachs." A lady mentioned by the same author had a natural aversion to salt, and was most dreadfully affected with worms during the whole of her life.

It is the universal use of salt by man and other animals that creates the principal demand for it, and leads to its production. The State or country having this indispensable substance within its borders is to that extent fortunate and independent. Salt is also extensively used in the economic arts; great quantities are employed in the manufacture of alkalies, which industry, in England, employs large capital and labor. With the exception of cheap coal, California possesses all the conditions necessary, with the advantage of large deposits of carbonate of soda, sulphate of soda, and great lakes containing carbonate of soda and sulphate of soda in solution. Salt is also used in cod fishery, pork and beef packing, in the manufacture of butter and cheese, to preserve barley and hay, as a manure for certain soils, as a glazing for pottery, in the roasting and metallurgy of ores, in the chlorination of auriferous pyrites, in which Grass Valley formerly consumed 1,000 tons annually, and in many minor ways.

The word "salt" is derived from the Latin word *sal*, but in chemistry it has a more extended meaning. The union of elements gives birth to compounds possessing widely different properties, called by chemists "acids" and "bases," which, having a strong affinity for each other, combine and form salts. The basic and acid properties become neutralized in the new compound. Common salt is a compound of the element sodium and the element chlorine in chemical equivalents. Sodium is a beautiful silver-white metal, which has so strong an affinity fer oxygen that it is never found uncombined in nature, and when isolated artificially, can only be preserved in the metallic state by protection from oxygen or its compounds. Chlorine is a gas which has a yellowish-green color, from which it derives its name. When subjected to a pressure sufficient to reduce it to one fifth the volume occupied at ordinary temperature, it becomes liquid. Chlorine is a corrosive and suffocating gas, which cannot be inhaled, even in small quantities, without danger.

In 1848–9, on the shores of San Francisco Bay, Native Californians gathered solar salt from natural reservoirs, which at high tides overflowed. The salt accumulated in these basins until it had formed a deposit of eight inches or more. When the natural deposit became exhausted, advantage was taken of the lesson taught by nature, and salt works of the crudest form were commenced, which led to the present extensive works. The lands were taken up first by launchers, mostly Swedes, who sailed their vessels and barges on the bay. The salt was of very inferior quality, and was produced to great disadvantage; but the consumers of that day were easily satisfied, and the price paid the producers well for their labors. Those companies first in the field were able to select locations best adapted for their purpose; those following them did not always succeed in finding fields so suitable. In 1862, John Quigley, said to be the pioneer, commenced work at Alvarado, or Union City. He was followed by Mr. F. A. Plummer. It is not surprising that when consumers became more fastidious, bay salt should have found it hard to compete with the better article imported from Liverpool and the east. About that time it was customary for merchants, both in Europe and the United States, to send out cargoes of assorted merchandise on venture, trusting to obtain for a portion such prices as would compensate for loss on others. It was not unusual to see large quantities of merchandise put up at auction and selling at prices much below cost of importation, while other goods readily brought many times the cost price. This condition of things flooded the State with merchandise, against which no manufacturer could compete, and goods forced on the market soon acquired a reputation for quality they did not always deserve. These circumstances have always counted against home production, and it is only lately that California manufacturers have been able to overcome the prejudices then formed. What has been said of imported goods generally, applies particularly to salt, which it has been shown was badly made at the commencement. Still the manufacture went on and was more or less profitable to those engaged in it. On the discovery of the silver mines at Washoe, there was a scarcity in the market. It was not then known that salt in the greatest abundance existed near Virginia City, and all the salt used in metallurgical works was sent from San Francisco and sold at thirty-five dollars per ton.

In 1868 salt works had extended from San Leandro Creek to Centerville, a distance of fifteen miles, and 17,000 tons were produced annually. There were seventeen companies, with a capital of

$1,200,000 invested in the works, and 100 laborers employed. From that time to the present the quality of the salt has been much improved, owing to more skillful and more careful manipulation; and while the importation of foreign salt still continues, the quantity is smaller every year, and it is admitted that California is quite able to produce all that can be demanded. At the time mentioned there were six steam mills in San Francisco employed in cleaning and grinding salt, a large proportion of which was for domestic use. The capital employed in these works was $250,000. In 1866 these mills ground and prepared 12,000 tons of salt.

For many years large quantities of salt were imported from Carmen Island, near Loretto, Lower California, Mexico. The salt was taken from a natural bed three miles long and half a mile wide. The island was formerly owned by the Mexican Government, but was sold to the Holliday Steamship Company. The salt has much the character of rock salt, being when first mined, in solid masses, having a slightly pink color, and being free from organic matter, could compete in quality with Liverpool salt, which was the secret of the success of its manufacture and sale. For some years the shipments were from three to five thousand tons annually. In 1868 the wholesale prices of salt were: Liverpool, twenty-five to twenty-seven dollars; Carmen Island, twelve to sixteen dollars; Bay, eight to thirteen dollars per ton.

About fourteen miles from the mouth of the Canada De Las Uvas, Kern County, the soil is impregnated with salt, holes dug in the ground fill with brine. Manufactured salt has been produced at this locality to a considerable extent by lixivation and crystallization. In 1864 a body of pure rock salt was found in Saline Valley, east of Owens Valley, Inyo County, which will supply a large quantity of that mineral when it is required. There are numerous salt springs in Owens Valley, which would probably yield a large quantity of brine if proper wells were bored.

In 1860 salt was manufactured in San Bernardino County. At first it was sent to San Francisco for a market, but when bay salt was more largely produced it was used only for local consumption. In 1867 salt works were erected in San Rafael and in Santa Clara County. There is a salt spring fourteen miles from Los Angeles which yields good salt. The product was formerly sent to San Francisco. Salt also occurs in Tehachipi Valley, Tulare County. A small quantity was worked in 1867.

The great salt bed in the Colorado Desert has been mentioned elsewhere; it will probably develop into a salt field, which will be of great importance to the State. Salt exists in the river sinks of the great basin, and is known to occur notably in Death Valley, Inyo County, at the sink of the Mojave; at the borax fields in San Bernardino County, and at many similar localities in the State.

There is said to be a deposit of rock salt in Lincoln County, Nevada, fifty miles north of Callville, on the Colorado River. It is stated on Holt's map that it is five miles long and six hundred feet high. Thirty-six miles southerly, on the Virgin River, lies the St. Thomas salt mine, and salt springs and deposits of gypsum are of frequent occurrence. The magnitude of these salt beds may be overstated, but there is little doubt as to there being a very large deposit, and that the salt is of the purest quality. A sample which I examined some years ago, proved to be absolutely pure, and was so free from water that a sample fused in a platinum crucible quietly and without decrepitation; it was clear as crystal, and wholly free from color. I have since seen similar specimens from the same locality. I mention this in particular, as an examination of the locality might lead to the discovery of potash deposits like those of Stassfurt in Prussia. It is not unreasonable to believe in the extent of this extraordinary salt bed, as described, for there is a similar deposit on the south side of the Island of San Domingo, which is six miles long and from half a mile to a mile wide. In its crude state it contains 96.79 per cent of pure chloride of sodium.

The following is taken from an Arizona paper of recent date:

Salt lagoons are met with in several places in Apache County, Arizona. The principal lake or lagoon is near the line of New Mexico. About 1,000,000 pounds are taken yearly from this lake, and with proper facilities it could be made to produce an almost unlimited supply. The salt is precipitated to the bottom of the lake, wagons are driven into the shallow water, and the glittering crystals shoveled in. This is one of the most valuable salt springs on the continent, and besides supplying cattle raisers in Apache and portions of Yavapai, furnishes large quantities for the working of silver ores.

Rock salt occurs in great quantities in many parts of the world, and geologists are divided as to whether these deposits are derived from ancient seas, or the sea takes its salt from them.

Salt is obtained from three principal sources—from rock salt, in which case it is extensively mined, and sometimes is sufficiently pure to be fit for consumption when simply crushed between rollers; from the concentration of natural brines pumped up from wells; and from the waters of the sea, or more frequently from the water of bays in which the sea water has become to a certain extent, although but slightly, concentrated. The latter production is called bay salt. At the present time, a large proportion of the salt produced in this State is obtained by this method, and the principal works are on the shores of the Bay of San Francisco, where the conditions required for the economic and extensive production of salt are found in the greatest perfection.

This method of producing salt is extensively practiced in Europe, and elsewhere. The fields, or salt marshes, are called "salt gardens," and may be found described in any work on technical chemistry. California has the advantage of possessing an even climate highly suitable for the production of salt. In other countries the salt manufacturers are subject to storms of rain, which interfere with the crystallization. This is never the case in California during the season, which can be depended upon.

The foreign salt gardens are principally on the shores of the Mediterranean, the waters of which are salter than those of the ocean. The following analysis of the waters of the Bay of San Francisco—samples taken off Oakland wharf, December, 1879—is by Fr. Gotzkow, chemist, temperature seventy-two Fahrenheit: Chloride of sodium, 23.756; chloride of potassium, 0.470; chloride of magnesium, 3.030; sulphate of lime, 1.263; sulphate of magnesium, 1.837; bromide of magnesium, 0.025; water, 969.619. Equal to: 0.297 potash, 12.695 soda, 0.520 lime, 1.728 magnesia, 1.968 sulphuric acid, 16.900 chlorine, 0.020 bromine, in 1,000 parts. The water of the bay is distinguished from sea water by the small proportion of potash and bromine. In the Atlantic Ocean, for instance, is found two and a half parts of potash and ten parts of bromine, against one part of the same in this bay.

On the eastern shore of the Bay of San Francisco extensive flats, very nearly level, extend for many miles. They may be seen figured on Whitney's map of the region adjacent to the Bay of San Francisco, published by the State Geological Survey, in 1873. It will be seen by this map that there is a large area suitable for the manufacture of salt, which, for convenience of reference, I have calculated into square miles and acres. The coast line, from the south line of San Antonio Creek, along the east side of the bay, to Mud Creek, and thence up the west side to Point San Bruno, is, by the scale of the map, sixty-four miles, and the area of swamp land, inside the tide land, from the points mentioned, is, roughly, 113.68 square miles, equal to 72,755 acres.

There is a large area about the bays of San Pablo and Suisun upon which salt could be made, if the waters of the Sacramento and San Joaquin Rivers do not too much dilute the sea water. It will be seen, by this, that the production of salt on the shores of San Francisco Bay is limited only by the demand. The source from which the salt is drawn is, of course, inexhaustible.

In writing of the manufacture of bay salt in California, it will be impossible to give a detailed description of each of the many works, for want of time to visit them all. The works of the Union Pacific Company were selected as a type, and the description will apply, in the main, to all the others.

The swamp or overflowed lands on the margin of the bay are so nearly level that the waters will generally follow any channel, natural or artificial, and may be conveyed from point to point in a slow current, by making the bottom of each basin a few inches lower than the preceding one. It sometimes becomes necessary to elevate the water when there is not sufficient head. This is done by a windmill of peculiar construction. The power is communicated by gearing to a paddle wheel running in a channel, into which the water flows from the lower level. By the revolutions of the paddle wheel the water is forced up an inclined plane to an elevation of a foot or so, which is all that is required. These mills are small copies of the great windmills used in Holland to drain lands reclaimed from the sea. They are provided with an iron strap and lever, by which the mill may be stopped when not required.

The first step in opening new salt works, is to throw up dykes or levees, partitioning off the available ground into basins of greater or less magnitude. Were it not for these dykes, the land would become wholly overflowed at the high tides on each month, but only partly so at other times. The outer basin, lying along the shore of the bay, is called the receiving reservoir, and is large enough to contain salt water sufficient to keep the inner basins supplied from tide to tide. It is furnished with wooden gates turning on pivots, which are opened by depressing a lever. The gates open inwards. When open, they allow of the free ingress of water, but when closed, resist the outflow; and the greater the pressure, the more tightly they shut; being set on an angle toward the pressure. In the channel leading to the flood-gates from the outside, there is a fence of pickets, to prevent any floating debris from passing in through the gate.

The Union Pacific Company has fifteen flood-gates, each twelve feet wide. In the receiving reservoir, all the mud and mechanical impurity settles. During the Spring tides, men are stationed at the gates, whose duty it is to open them when the tide flows, and to shut them at the commencement of the ebb. It sometimes requires only two nights to fill the receiving reservoir; but at others, five or six. As the gates must shut perfectly tight, to retain the water, considerable attention and care are required to effect this, as crabs and small floating refuse get in, when it becomes necessary to shovel in earth until a perfect joint is made. From the receiving reservoir, the water is conducted as required into secondary tanks, to the extent of 1,000,000 gallons daily, where it is allowed to remain until it becomes partly concentrated by evaporation, during which it lets the sulphate of lime fall as a precipitate, which collects in large quantities, and although now considered worthless, it will, in the future, be sought as a fertilizer. From the secondary basins, the water, freed in part from impurity, is conducted into another set, where it becomes still more concentrated by evaporation to brine, having a specific gravity of 1.2082, or twenty-five degrees Beaume, which is a saturated solution. It is then conveyed into vats and crystallizing basins, or "making ponds," as they are called. After remaining for the required time, nearly all the salt crystallizes out, and the mother liquor, holding in solution magnesia salts, and other impurities, and technically called "bitterns," is drawn off, and generally allowed to go to waste; a small quantity only being used in the manufacture of carbonate of magnesia, yet to be described.

The crystallizing vats, basins, or pans, are generally about an acre in extent. At the new works of the Union Pacific Company, six ponds measure eight acres. The salt taken from one of these basins contained 200 tons, and measured at the base of the pile thirty by forty feet, and was sixteen feet high. These basins are filled but once for each crystallization. There were at the time of my visit thirty piles of salt, from 200 to 1,200 tons each, at the works of the Union Pacific Company, and thirty-five other piles in sight belonging to other individuals and companies.

Most of the crystallizing ponds have mud bottoms and sides. The salt, of course, is somewhat inferior, or at least less clean than that from others which are floored with planed boards. It is claimed that the low price of salt will not pay for the additional capital required to build the tanks and reservoirs of cement or the cheaper béton; but I am convinced that such works will in time replace the mud-bottomed basins of the present.

When the mother liquors are drawn off the salt is carefully shoveled into small piles, like haycocks in a field, by a gang of sixteen men. It is then wheeled in barrows to the large piles, where it stands through at least one rainy season, during which the deliquescent salts of magnesia, and the coloring matter imparted probably by organic matter, leach out, and the salt becomes ready for the market. When the salt crop has been gathered from one of these basins, a set of men wearing wide boards on their feet, like snowshoes, walk over the surface, and with shovels flatten and otherwise smooth the surface of the rather soft mud, preparatory to refilling with brine.

For the manufacture of salt for table use the Union Pacific Company have a set of elevated pans of wood, into which the cleanest brine is pumped by windmills. There is no contamination, and the salt from these crystallizers is pure as salt can be made in a large way. Salt is ground at these works in a mill of peculiar construction. It consists of a corrugated roller of granite, which makes 700 revolutions per minute; it is driven by a portable steam engine. The salt passes between the roller and a block of burr millstone.

Analysis of Bay Salt coarsely ground and dried, made by Fr. Gutzkow, June, 1880.

Sulphate of soda	0.019
Sulphate of lime	0.436
Chloride of magnesium	0.061
Chloride of sodium and potassium	99.484
Organic matter	trace.
	100,000

The mother liquors from the crystallizers contain magnesia in considerable quantities, a portion of which it has been found profitable to recover. The company have contracts for 50,000 pounds, but could easily produce 100,000 pounds each season, if the product could find a market. Mr. Fr. Gutzkow has charge of the works, and the following analysis of the mother liquors or bitterns was made by him in December, 1879—specific gravity 28° Baume or 1.2394, temperature 65° Fahrenheit, and calculated for 1,000 parts:

Chloride of sodium, salt	165.969
Chloride of magnesium	108.569
Sulphate of potash	14.533
Sulphate of magnesia	55.389
Bromide of magnesium	1.090
Total solids	345.550
Water	654.450
	1000.000
Equal to—	
Potash	7.859
Soda	87.941
Magnesia	64.400
Sulphuric acid	43.600
Chlorine	183.827
Bromine	0.218
	387.845

Magnesia is used in the manufacture of explosives, being employed as an absorbent for nitro-glycerine in the same manner as infusorial or diatomaceous earth. The Hercules Powder Company use all that the Union Salt Company makes. The mother liquors are pumped up into wooden tanks furnished with stirring apparatus, and saturated with milk of lime to decompose the sulphates present and to lock up the sulphuric acid. The clear liquor containing chloride of magnesium is then treated with carbonic acid generated from burning coke, which precipitates carbonate of magnesia; this is removed in a pasty state and dried on iron plates over steam. The American Salt Company has furnished salt to Hollister and Santa Clara to be used as a fertilizer.

The capital employed in the manufacture of salt in California is estimated at $365,650; the Union Pacific Company, which is the largest in the State, has $100,000 invested. The yield of salt from the Union Pacific works for ten years has been as follows:

Year.	Tons.	Sacks.
1872	1,700	19,958
1873	5,000	63,300
1874	4,600	57,401
1875	7,000	100,430
1876	8,000	101,925
1877	11,000	144,570
1878	7,000	117,967
1879	9,000	130,147
1880	9,250	132,132
Totals	62,550	867,830

In 1882 they expect to make from 12,000 to 15,000 tons. Thirty cubic feet of dry salt equals one ton.

In climates more temperate, or unsuited for rapid evaporation, the weak brines, or sea water, are first subjected to a process called "graduation." Large buildings are constructed, open at the sides, from thirty to forty feet high, eighteen to twenty-five feet wide, and sometimes 2,000 feet long. The building is set at right angles with the prevailing winds. The floor is occupied by a basin of concrete or hydraulic cement, with walls three feet high. In this basin is piled an immense mass of faggots; the pile is of oblong shape, and somewhat smaller in size than the building. The brines are pumped up into shallow wooden pans or troughs, overlying the pile of brushwood. The troughs are pierced with a multitude of small holes through which the brines percolate in small streams.

As the liquid trickles down through the brushwood, it is exposed to the air in thin strata, and becomes rapidly concentrated. It sometimes requires to be pumped three times before it attains the density of twenty-five degrees Beaume, when it is run into crystallizing vats. This operation, indispensable in some climates, and under some conditions, is unnecessary on the shores of San Francisco Bay, where the air is dry during a great portion of the year, during which no rain falls to interfere with the evaporation, and where extensive salt marshes afford ample room for salt gardens.

Sulphate of lime forms on the faggots as an incrustation, which, in time—from five to eight years—so fills the interstices that the pile becomes worthless, and must be replaced by another. The graduation process is not new. In 1812, Thompson, in his travels in Sweden, saw, at the copper mines at Fahlun, natural solutions of sulphate of iron (from which the copper had been precipitated by scrap iron), concentrated in this manner. On pumping the extremely dilute solution up seven times, it had nearly reached the point of crystallization, when it was conducted into suitable lead-lined pans, in which it was evaporated by heat to the required density and run into crystallizing vats.

This economical method of concentration might be practiced to advantage in various metallurgical operations in California, and the pumping done by large windmills built and managed on the Dutch plan.

A more detailed description of graduation may be found in Lippincott's Encyclopædia of Chemistry, vol. 2, folio 733, and an engraving showing mode of construction in Precis de Chimie, by L. Troost, Paris, 1873.

The following statistics of the manufacture and production of salt in California are from the census bulletin, No. 245, preliminary report on the salt manufacture in the United States:

TABLE 1.

Census Year of 1880—*Yield of Salt.*

From sea or bay water	878,093 bushels.
From inland lakes or natural deposits	6,350 bushels.

One bushel is equal to fifty-six pounds.

Mr. Henry Osterloh, salt dealer, estimates the production of bay salt for the year 1882 at 42,000 tons, while Mr. A. B. Winegar thinks the actual production will not exceed 25,000 to 30,000 tons.

TABLE 2.

Exhibiting the Total Manufacture of Salt in California.

Number of establishments	25
Capital	$365,650
Greatest number of hands employed at any one time during the year	280
Average number of hands employed	184
Total amount paid in wages during the year	$49,120
Machines, if by boiling process—	
Number of blocks	2
Number of kettles	58
Aggregate capacity in gallons	7,250
Number of pans	2
Aggregate capacity in gallons	500
Materials, if by boiling process—	
Number of tons of coal	13
Value of coal	$76
Number of cords of wood	125
Value of wood	$300
Value of all other materials	$40
Total value of all materials	$416
Machines, if by solar evaporation—	
Number of vats	185
Aggregate area in square feet	14,228,802
Total value of all materials	$18,079
Number of bushels of salt produced	884,443
Value of same	$121,950

The following is a list of the salt producers of Alameda County as far as can be obtained: Baron, Richard; Chisholm, Captain, estate of; Christianson, Peter; Jesson, Peter H.; Marsicano, Patrizio; Michaelson, John; Michaelson, Peter; Oliver, Andrew; Olsen estate; Pestdorf, Detrich; Pioneer and American Salt Companies United; Plummer, Charles A.; Plummer, John Jr.; Quigley, John, Alvarado Salt Works; Tuckson, J. P.; Union Pacific Salt Company; Whisby, L. N.

TABLE 3.

Exhibiting a Comparative Statement of the Salt Industry, according to the Census Reports of 1880, 1870, *and* 1860, *for the principal salt-producing States.*

States.	Number of Establishments.			Number of Blocks or Furnaces.			Number of Vats or Ponds.			Capital Employed.		
	1880.	1870.	1860.	1880.	1870.	1860.*	1880.	1870.	1860.*	1880.	1870.	1860.
California	25	8	2	2			185	8		$365,650	$66,500	$800
Kentucky	3	4	6	3						20,500	16,500	70,000
Massachusetts	6	9	13				456	2,755		9,000	27,300	30,525
Michigan	86	65	1	104	76		3,750	3,461		2,147,209	1,717,500	100,000
New York	69	93	296	134	147		42,939	18,106		2,286,081	1,584,211	2,313,590
Ohio	25	40	28	26	131					832,600	1,085,904	338,700
Pennsylvania	16	27	34	16	4			2		234,500	171,700	190,800
Utah	10	1		2			18			13,400	650	
Virginia and West Virginia	11	20	14	20						1,909,500	1,631,300	523,800
Other States	13	15	5	2	44		98	193		407,300	260,050	124,000
Totals	264	282	399	309	402		47,446	24,525		$8,225,740	$6,561,615	$3,692,215

States.	Wages Paid.			Total Value of all Materials Used.			Bushels of Salt Produced.			Total Value of Salt Produced.		
	1880.	1870.	1860.	1880.	1870.	1860.	1880.	1870.	1860.	1880.	1870.	1860.
California	$49,120	$13,400	$5,400	$18,495			884,443	174,855	44,000	$121,950	$48,150	$7,100
Kentucky	8,750	10,070	14,978	9,008	$5,520	$7,450	83,000	64,000	169,665	21,950	20,920	41,190
Massachusetts	1,030	1,875	5,892	20	250	1,020	9,975	22,846	31,525	3,950	11,550	9,832
Michigan	540,902	331,239	200	1,009,733	410,561	275	12,425,885	3,981,316	2,360	2,271,913	1,176,811	600
New York	274,087	204,226	24,520	507,020	494,854	676,301	8,748,203	†4,977,720	7,521,335	1,106,740	925,709	1,289,511
Ohio	105,261	161,420	91,524	202,543	352,922	139,627	2,650,301	2,898,649	1,743,200	363,791	773,492	276,871
Pennsylvania	52,047	57,980	64,776	74,047	83,203	48,603	851,450	579,970	1,011,800	177,415	187,312	196,916
Utah	20,932	300		4,000	240		483,800	1,950		60,180	780	
Virginia and West Virginia	174,446	290,800	148,464	231,113	385,255	166,204	3,105,333	4,635,813	2,076,513	508,047	1,508,855	410,684
Other States	29,538	75,600	16,200	15,445	27,865	15,500	557,908	268,986	116,800	181,700	164,650	56,800
Totals	**$1,256,113**	**$1,146,910**	**$371,954**	**$2,071,424**	**$1,760,670**	**$1,054,980**	**29,800,298**	**17,606,105**	**12,717,198**	**$4,817,636**	**$4,818,229**	**$2,289,504**

* Not enumerated.

† These figures are evidently incorrect, as the New York State Salt Inspector reported 8,662,237 bushels in 1869 and 8,748,115 bushels in 1870.

MUD VOLCANOES AND COLORADO DESERT.

On the thirteenth of January, 1881, I left San Francisco to study the mud volcanoes in the Colorado desert, in San Diego County, desiring not only to obtain an idea of their general character, but specially to ascertain if the emitted steam contained boracic acid, like similar solfatara in Tuscany, and if there were beds of borax, nitrate of soda, or other salts, aside from chloride of sodium, which is known to occur in large quantities in the dry lake or sink.

At Los Angeles I visited the Brea ranch, and studied the deposit of asphaltum, and the methods employed in purifying the crude material for use in the arts. From Los Angeles to Colton the country is fertile, well settled, and is rightly considered the garden spot of the State. Southeasterly after leaving Colton, along the Southern Pacific Railroad, the lands become gradually more sterile, grassy fields being succeeded by desert plains, and the semblance of ground swells on an ocean of white shifting sand. At Dos Palmas the whole face of the country has become transformed into a veritable sahara, without an oasis to relieve the utter desolation of the scene. From Dos Palmas to Volcanic Station the distance is 18.43 miles, and the elevation above the former thirty-three feet. Thanks to Mr. A. N. Towne, of the Central Pacific Railroad, I was provided with letters of introduction to railroad officials, and was furnished with the authority and means to stop trains, if found necessary, on the desert. Mr. F. M. Smith accompanied me, being interested in the same direction. We were provided with an abundance of supplies and blankets, and had planned to camp near the mud volcanoes for at least ten days, extending our researches to the whole region drained by the saline sink before mentioned.

At Volcano Station, which we reached near midnight, we found ample accommodations, including plenty of water. The station master, Mr. Pat. Curley, to whom I had letters of introduction, was very attentive, and put himself to considerable inconvenience to make us comfortable, and to afford every information. On the morning of January fifteenth, at daylight, the thermometer stood at 44 degrees, with a most delightfully pure and clear atmosphere. Mr. Curley informed me that in Summer the heat is almost unbearable, the thermometer marking 125 degrees in the shade, in the afternoon, and at night 110 degrees. To guard against the effect of the intense heat of the sun, the roof of the station house has been built double, one roof being supported at an elevation three or four feet above the other. This arrangement has been found to modify the otherwise almost insupportable heat.

Among the first striking features of the desert that we observed in the morning, which we had noticed indistinctly by moonlight, from the train, were channels cut in the soil, all trending in the direction of the salt bed. They had undoubtedly been made by swift running water—were very numerous, and varied in width and depth. The station master, who has been here since 1876, has never seen any water in them. Near the station there is a small solfataric opening, feebly active, but nearly extinct. Walking a few yards to it we observed certain phenomena, which we regarded with much interest, not having the experience afterwards made at the great salses, which we came purposely to examine. We found a depression of a few feet, in the nearly level plain of the desert, of about half an acre unevenly circular in form. Near the center, were several small cones, three or four feet high, from the top or summits of which issued sulphurous, carbonic, and hydrosulphuric acid gases, with a low incessant hiss. On holding the hand very near, the gentle force of the current could be distinctly felt. Some were found to be quite hot, but no steam came from them. A silver coin laid on an outspread handkerchief, over the orifice, was quickly blackened by the invisible vapors. The sulphurous odor was oppressive if the cones were approached too near from the lea. The surface of the depressed or sunken area was more than damp, and a small stream of good water trickled down and sank out of sight in the sands.

At breakfast Mr. Curley was plied with questions, to which he gave intelligent and instructive answers, and in this way much valuable information was obtained as to the nature and peculiarities of the great salses. From him we learned that at certain irregular intervals, the air in the direction of the mud volcanoes is loaded with vapors and steam, in great white masses, like clouds, indicating unusual and violent eruptions. I had long thought that these salses were geysers, like, or similar in some ways, to those of Iceland, the Yellowstone, and New Zealand. This was the first confirmatory evidence I had obtained. I have since referred to the published accounts of those who have visited the mud volcanoes, which, added to my own observations, have strengthened that opinion. These references will be given in their proper places.

At about sunrise Mr. Smith and myself prepared for the first visit to the mud volcanoes, distant about six miles from the station. A Chinaman was directed by Mr. Curley to accompany us, to assist in carrying the instruments and provisions. It was our intention to make the first day a reconnaissance only, and to work up the details during future visits. I was provided with maps from the land and railroad offices, which gave the exact bearings. Sweeping the sandy horizon with a field glass, I saw far away in the direction of some small buttes mentioned in Dr. Veach's account, jets and small clouds of steam. There being no apparent obstructions in the way, our party marched directly for the salses. At a short distance we came to the verge of one of the ravines mentioned by Prof. Blake, and figured on folio 101, vol. 5, Pacific Railroad Reports. It was fifty to seventy-five feet wide and ten to twenty feet deep, with steep sides and level bed. There were marks of water erosion on the banks of the ravine, which had the appearance of being the dried up bed of a small river. We noticed the alternate bluff bank with opposite sand bar, which may be seen in any river flowing in a plain. The ravine only required water to complete the river. Crossing this ravine without much difficulty, and without inconvenience, except fatigue, we passed on to meet with and cross another and another exactly similar, except in width, until our course seemed an almost endless repetition of climbing down one side and up the other of these ravines, making the passage toilsome, but not uninteresting, for the scientific observer is never at a loss for objects of interest, and specially so in a region so remarkable as this. We soon noticed that the soil was to a large extent made up of minute turretted shells, so small that they could scarcely be distinguished from the grains of sand. At certain points they were blown by the wind into windrows, and lay in vast numbers, concentrated from the sands by a natural winnowing process. These shells are the *Tryonia clathrata* of Stimpson tertiary fossils, described in the Smithsonian miscellaneous collections, number 144, part 3, folio 70. Specimens may be seen in the State Museum numbered 2735 in the catalogue. On my return to San Francisco I made experiments showing that it required 166,000 of these minute shells to weigh a pound.

The singular effect of the wind on the ever-drifting sands, the stratified sides of the ravines—some of which were composed largely of shells, the water-worn pebbles, and occasional masses of pumice-stone—volcanic tramps from some distant locality, sheets of travertine deposited by a vanished spring, or at the bottom of an ancient lake, the wide expanse of white sand skirted by distant hills blue and shadowy, the isolated sage bush, dwarfed in stature, but growing in defiance of the winds and drifting sands, striving in concert to uproot and destroy what seemed an innovation, the sudden rush of the horned toad (*Phrynosoma regale*) like a little flash, as he scampered over the hot sands, all added to the general interest, and made the transit from the station both interesting and instructive.

The desert mirage so often described cannot be appreciated without being seen. When we had passed over about half the distance we seemed to have entered a charmed circle. The whole landscape changed. Instead of the sandy plain of reality, a visionary lake of water lay before us skirted with trees which required no vivid imagination to recognize as palms. Although knowing this to be a mirage, it was almost impossible to see anything illusive in the picture of the lake with hills now in the foreground transformed into islands. Turning toward the station it was seen as a castle several stories high. As we looked, the upper portion became detached, and by some optical fiction globular, and seemed to rise like a balloon and fade away in the air. In the distance might be seen a large object of undefined shape, seemingly a mile away; as we approached, it rapidly dwindled to a fragment of pumice-stone, not bigger than an egg—the real distance being not more than a hundred yards. Hogarth's picture of perspective would not seem so absurd, were it placed in a phantom picture gallery in the Colorado Desert.

As we pushed forward we reached a point where the ground became wet and muddy; all the ravines were passed, and an inclined plane sloped away toward the great salt basin. Not far distant were the cones of the mud volcanoes, steam issuing with greater or less force from many of them; some inactive, stood in a ruined condition, their summits broken and their sides coated with dried mud, once ejected from their craters during a period of activity. Although the distance was now short, and the roar of the steam could be distinctly heard, it seemed at one time as if the attempt to reach them would have to be abandoned, for the mud over which we were passing became so tenacious, that it clung to our feet like snow in a Winter thaw. At each step our feet seemed to sink a little deeper, and it became a question whether we would or would not become mired; but we found that the soft mud was superficial, and that by moving forward without stopping, we could get over the surface without actual danger. We finally arrived at the margin of the salses, and found an elevated rim, comparatively dry. While the Chinaman prepared lunch we made a partial examination of the surroundings and found them quite as interesting as we had expected. There are three mud lakes, or basins, two connected by a narrow channel, and the three separated from the others one hundred feet or so. The extreme length of the chain of lakes is about 1,400 feet by 300 wide. In the widest part these lakes or cauldrons are in a state of activity, caused apparently by escaping gases. The water is not hot but only warm; the temperature, taken with a thermometer, was eighty-five degrees Fahrenheit; the same instrument placed in the vent of one of the active cones marked one hundred and sixty-five degrees. At other points, yet to be described, the water was actually boiling. The temperature elsewhere was not taken for reasons to be given. The mud in the basins is exceedingly tough, like that we crossed in approaching, and resisted the force of the gases in a constant warfare.

It was strange to stand on the brim of these lakes and watch the action of the opposing forces. All over the surface globular elevations would appear, rising slowly as if a ball a foot in diameter was being pushed up from below. This would sometimes break at first, but more frequently the attempt would be made several times in succession before the tough mud would yield and the escape of gas allow the mud to sink into rest. At other times, after a fierce struggle and after several attempts, the victorious and gigantic bubble would burst with a loud and indescribable sound, throwing the mud high in the air, to fall with a flop—I can think of no better word to use. The rims of these basins were considerably elevated, evidently caused by frequent overflow. And for some distance in every direction the surface of the ground was smooth, being coated with the same thick mud. It was clear to me that overflows were frequent and intermittent, and it was decided to remain, camped near by, for a number of days, if necessary, to ascertain if these might not be active geysers, but the sequel will show that we were compelled to leave, not only without deciding this, but without carrying out any of the details of our plan.

The two largest basins are separated by a narrow bridge or bank of earth, upon which and near which the principal mud volcanoes are situated. The largest of these lakes is 750 feet long, and the width 300. The lesser basin of the pair is 156 feet long by 210 wide. East of these lies the detached lake, which is 420 feet long by 240 wide. On the borders of all the lakes are the volcanic cones, if it is proper to call them so. They are rather solfataric vents or escape pipes for the emanating gases and steam, and are built up wholly by this action. The soft mud is forced up by escaping gas and steam at certain points, where they find an orifice or weak place in the ground, and a little rim of cooled or partly dried mud is formed. This nucleus grows rapidly when once commenced; the ejected mud overflows and runs down the sides, adding to the bulk of the cone. The nature of the muddy overflow is such that it does not form a cone with a wide base, as would be the case if dry sand was poured down slowly from a spout, but shows a tendency to build up sharp pinnacles, the angles of which are frequently from sixty to seventy-five degrees from the horizontal. The ground being soft and the crust thin the cones are naturally short lived, except when standing on comparatively solid ground. When the weight of the cone becomes too great for the strength of the crust it sinks to the level of the surrounding ground, and another is immediately commenced. From the active vents there is an incessant flow or escape of gases and steam, sometimes noiseless or with only a hiss, at others with a roar like a locomotive engine when the safety valve is blowing off. The principal steam vent is not from a cone but from an orifice in the more solid ground, which was named "vixen" by our party, from its vicious character and spiteful defense against any approach. The ground for hundreds of feet about these cones is unstable in the extreme; the approach to the volcanoes is actually dangerous, and cannot be made too carefully. Probably there is no more curious sight among the natural curiosities of California than the spiteful steam jets of the mud volcanoes, and the singular action of the gases in the basins.

Many of the steam vents are fringed with exquisite crystals of bright yellow sulphur and snow-white salt, which in some cases partly cover the sides of the cones. From a distance, the blue mud of the cones, contrasting with the salt and sulphur, have the appearance of miniature mountains covered with flowers. The cones vary in height from three to ten feet. At only one point, near the vixen, were seen singular inverted stalactites, built up in the same manner as the cones, but of carbonate of lime, hard and dense. None were more than a few inches in diameter, while some of them were very small. Each has a channel for the escape of the steam. Of all the curious things seen at this most singular place, these formations are the most so. They are like branching coral forming in the sea, of a dirty white color, tipped, in many cases, with red—a remarkable instance of the deposition of minerals by the action of thermal springs. The specimens have been numbered 2404, and placed in the State Museum. A sample of the mud brought by me to San Francisco, and examined in my laboratory, has proved to be very interesting. It was boiled in distilled water, and the solution evaporated to dryness. A large quantity of deliquescent salts remained. A portion of this was redissolved, placed on a glass slide, and slowly evaporated. Under the microscope, hopper-shaped crystals, in great abundance, appeared, characteristic of common salt, and octahedral crystals, which could not be identified. Feathery crystal tufts of carbonate of soda, and tabular plates in piles, like blood corpuscles, characteristic of boracic acid, also made their appearance. The remainder of the salt residue was then treated with sulphuric acid and alcohol, which was heated and inflamed in a dark room, when an unmistakable green color was observed, proving the presence of boracic acid. The sand, filtered from the aqueous solution, was dried, examined under the microscope, and found to be very fine sand, water-worn, similar to the sands of the desert. It was mostly quartz, with flakes of white and colored mica. I noticed a peculiar scaly mineral, presenting the appearance of having been a silicious or calcareous coating on a grain of sand. Some of the quartz was amethystine, and a portion chalcedonic; there were a few grains that seemed to be olivine. Noticing what appeared to be calcite, I subjected a portion of the sand to the action of hydrochloric acid. A brisk effervescence took place, and a considerable portion dissolved, imparting a golden yellow color to the acid, which the proper reagents proved to be iron. The acid solution gave also a strong reaction for lime.

An examination was made of the stalactites, which proved to be very interesting. One about five inches long and half an inch in diameter, was cut across the middle and the end ground down on a stone and polished. This under the microscope, with a low power—a four-inch objective—was seen to be formed in concentric rings quite distinct, near the outer surface, but showing a confused mass of calcite crystals near the central orifice, which was open throughout the entire length. When broken transversely an arrangement of crystals in plumose form, radiating in graceful lines in an upward curve from the orifice, seemed to show that the escaping steam had expanded, as it naturally would, depositing lime carbonate in the feathery spray before mentioned. The tip of the stalactite—I still call them so for the want of a better name—was colored a dirty brick red, probably from oxidized iron; but I remember noticing this color as being more striking and brilliant as they grew in their native beds. This may be for one or several reasons; it may be partly due to imagination, to the iron having undergone a recent change, or to their being wet when first seen. The orifice at a distance of two inches from the top is circular and about two millimeters in diameter. At the tip it is six millimeters long and two wide. The outer surface of the stalactite is rugose, and divided into very irregular rings, which seem to indicate periods of greater or less activity. The careful microscopical study of these very interesting bodies has led me to the opinion that they were formed by the combined agency of steam, carbonic acid, and water holding lime in solution. As the steam escaped in company with the carbonic acid it carried with it mechanically hot water containing lime salts, a portion of which was precipitated, leaving about the tip a spongy mass of crystals, through which the steam still passed freely. An examination of the still spongy tip of the stalactite seems to verify this opinion. This would also account for the plumose form of the deposition. After a time the lateral vents became closed, and the same reactions were repeated above. The formation of these stalactites must be very slow, for the little bed in which they grow has not changed materially for thirty-one years, since they were visited by Dr. Le Conte. Subjected to chemical examination they were found to be principally calcite, with small quantities of silicia, iron, alumina, magnesia, sulphuric acid, and common salt. In a closed tube a little water was given off, but the fragment subjected to heat underwent no other visible change. Before the blowpipe the mineral did not fall to a powder like aragonite, but lost carbonic acid, and became alkaline. In hydrochloric acid it nearly all dissolved, with violent effervescence.

The salses that we first visited are not, by any means, the only evidence in the locality of intense solfataric action. In several directions extinct mud volcanoes were seen, some of which had been quite as extensive as those now active. As we crossed the plains, we had seen, at several points, small jets of steam, which we passed without special notice, as we expected to remain long enough in the neighborhood to visit them all. After we had taken our lunch, Mr. Smith walked over to the nearest extinct cones, while I began to make a survey of the ground near the "vixen." In doing so, I passed over the same area that we had examined together. In taking the temperature of a steaming vent, I felt the crust sinking, and, before I could escape, one of my feet broke through, and I was so severely burned that I was compelled to return, as best I could, to the station, and to San Francisco, where I was confined to my room for six weeks. I consider my escape from instant death a narrow one, for had both feet broken through at the same time, I should, no doubt, have sunk out of sight, as did, perhaps, the French trader, as related by Dr. Le Conte. I mention this fact specially to warn future visitors to use the utmost caution in approaching these solfatara, and not to trust too much to appearances. It would be best to use wide, long boards, attached to the feet like snowshoes, or to slide the boards along, never trusting the solid looking but treacherous crust. My accident defeated the object of the visit, and I was compelled to leave the questions of the presence of boracic acid in the steam, and of borax and nitrate of soda in the soil, unanswered.

The mud volcanoes were first made known to the scientific world by John Le Conte, M. D., of Philadelphia, who visited them in company with Major Heintzelman, of the United States army, in the latter part of October, 1850. A very interesting account of his visit may be found in Vol. 19 of the American Journal of Science, second series, No. 55, 1855, folio 1, to which the reader is referred. The following extracts are from the article mentioned. Mysterious accounts of an active volcano in the midst of a vast plain covered with salt had reached San Diego. Major Heintzelman, then in command of troops about to march to Fort Yuma, determined to visit the locality and investigate the rumors. He left San Philipe, in company with Dr. Le Conte, on the twenty-eighth day of October, 1850. The direction of the march was southeast to Vallecito; thence easterly to an Indian village on New River, crossing Carrizo Creek; thence in a northeasterly direction into the heart of the desert. Uncommon lowness of the Colorado had caused the bed of New River to be dry. As the party neared the volcanoes the Indian guides evinced great terror and refused to go forward, stating that devils had been known to rise from the volcanoes, in the form of great black birds, which pounced down on their victims and devoured them. There is a tradition among the Indians that a trader, Juan Longicuisse, met with a fearful fate years before, while visiting the locality, being destroyed by the dark birds. Dr. Le Conte mentions the inverted stalactites, and the steam jet, named by our party "the vixen." He found a salt which he believed to be sal ammoniac, but expressed a doubt as to its identity, in a foot note. The party had difficulty in approaching the mud volcanoes, and found the thin crust to tremble beneath their feet.

In December, 1853, there was a violent earthquake, which caused the ground to open near Fort Yuma. From the opening, mud, sand, and water were thrown up. Portions of the mountains miles away were seen to fall, and these, or similar salses, emitted immense clouds of steam.

Professor W. P. Blake examined the desert in November, 1853. His route was from Los Angeles via San Bernardino, through San Gorgonio Pass, and along the west side of the desert, to Carrizo Creek, and by the emigrant road to Vallecito, San Felipe, and Warner's; thence returning to Vallecito, Carrizo Creek, Big Lagoon, and the Colorado. By looking over this route on the map, it will be seen that he did not pass near the volcanoes. He mentions them, however, having heard of them from Major Heintzelman. The land on which the mud volcanoes lie has been sectionized by the United States surveyors, and the following is a memorandum from their field notes:

Mud volcanoes in the northern part of section 15, township 11 south, range 13 east, San Bernardino meridian, in particular, emit steam and throw up high stacks of mud. There are two cauldrons of boiling mud, three chains in diameter, and three ponds of water—one of which is too hot to hold the hand in. One is also twenty-five yards in diameter and very deep. The water is strongly impregnated with salt and sulphur. Variation of the compass, 13.41 east.

In July, 1857, Dr. J. A. Veatch visited the mud volcanoes in his well known search for borax, and published a very interesting and correct description of them in the proceedings of the California Academy of Science, Volume I, folio 104. While the descriptions are carefully given, and are in every way correct, the engraving is likely to mislead the reader as to the magnitude of the cones. If the figure of a man pictured as climbing over one of the broken cones was erased, the drawing would be tolerably correct. By the introduction of the figure the volcanoes are made to appear much too large. In the water Dr. Veatch found boracic acid only in small quantities, but sufficient to be unequivocally determined.

No visitor has remained long enough at the mud volcanoes to learn more of their habits than could be gained in a few hours observation; and the question as to whether they are active geysers or not is still unanswered. No visitor has been able to remain long at the locality, or has had the curiosity to do so. Dr. LeConte's visit was of but a few hours duration; Dr. Veatch's one and a quarter hours; and the stay of our party was terminated by the accident mentioned, in about two hours. Dr. Veatch's visit was made in midsummer, when the heat was almost unbearable, and he could not stay on that account, and for want of water.

The great Colorado Desert of California and Northern Mexico has long been recognized as a locality of special interest. The route of Coronado's army, celebrated in the history of the Pacific Coast, was along the eastern shore of the Gulf of California to Sonora, thence north to Tucson, crossing the Gila River at Casa Grande. Melchor De Diaz marched to a point near the head of the gulf, followed up the west side of the Colorado, and crossed that river above Yuma. The first account of the Seven Cities of Cibola was received in New Spain in 1530. An attempt to visit them was made by Nuno De Guzman, with an army of 400 Spaniards and 1,400 Indians, who reached a point at which the terrors of the desert and the rugged character of the mountains seemed to offer insurmountable obstacles. For this reason the enterprise was abandoned, and the commander turned his attention to colonizing the Province and City of Culiacan instead.

In 1538 the excitement was renewed by the arrival of a shipwrecked party, which had crossed the land, and claimed to have seen the cities of Cibola. In 1540 Coronado's march was made. In the same year Fernando Alarcon discovered the mouth of the Colorado River—Rio Del Tezon—and made known the fact that the supposed Sea of California was a gulf, and California a peninsula instead of an island. From the date of the above mentioned events to the present time the great Colorado Desert has been regarded as one of the geographical wonders of the world, and by those who have not studied the subject, as a region wholly barren and desolate, and worthless to the last degree.

The desert proper extends in a direction nearly northwest and southeast, from latitude 31.30 north and longitude 114 west to latitude 34 and longitude 117, being approximately 200 miles long by 70 miles in width at the widest part. The boundary line between Mexico and the United States passes obliquely through its greatest breadth. The area indicated above does not represent the entire desert, which has many branches of greater or less extent, notably one extending far up the valley of the Gila River.

In the fifth volume of the Pacific Railroad Reports may be found an account of the reconnaissance of a portion of the Colorado Desert by Professor W. P. Blake, to which the reader is referred for many interesting particulars.

Professor Blake noticed a number of hot and soda springs. One spring seen by him had a temperature of 120 degrees, from which emanations of sulphuretted hydrogen blackened painted buckets. He noticed also a calcareous incrustation on the rocks, indicating the water level of an ancient lake. For a long distance this water line maintained its level, indicating a lake or large bay, with a bottom of varying depth. Fossils and fresh water shells were numerous, and the following species were collected: *Anodonta californiensis*, Lea; *Annicola protea*, Gould; *A. longinqua; Cyclas*, imperfect specimen; *Gnathodon lecontei*, Con.; *Physa humerosa*, Gould; *Planorbis ammon*.

Other fossil shells were found, thought by Professor Blake to be miocene tertiary. The following species were new: *Anomia subcostata*, Gould; *Ostrea vespertina; O. heermani; Pecten deserti.*

It is the opinion of Professor Blake that the waters of the Gulf of California once covered the whole desert 170 miles inland; and he thinks if the alluvial deposits brought down by the Colorado River were removed, the gulf would flow inward and again occupy its ancient bed. When the stupendous work done by the Colorado River in cutting the deep cañons along its course is considered, it is easy to realize the vast quantity of detritus brought down and deposited by that industrious and mighty river. Its delta must have gradually forced the Gulf of California to recede, finally cutting off a portion which was at first an inland salt lake. As the banks of the river rose, causing the water to flow down the gulf, the lake gradually dried up, leaving in its lowest depression an extensive bed of salt, now known to exist. The bed of the ancient sea probably became leached by the waters of the overflowing Colorado and occasional rainfall, until all the salt became concentrated in the sink, which, after a time, became covered by clay and river silt, which resisted the tendency of the fresh water to dissolve the salt, and an intermittent lake of fresh water was formed, which continued until the conditions were changed, and finally dried up, leaving the desert in its present condition.

The river still continues to overflow at certain seasons, forming a series of small lakes which at other times dry up. This remarkable river takes its name (Colorado) from the discoloration of its waters by the great quantity of red silt carried down to the sea; and, for the same reason, the Gulf of California was formerly called the "Vermilion Sea." There is evidence as to frequent shifting of the sands of the desert not only by water, but by the wind, and many of the rocks are worn and polished by the moving sands. Professor Blake was the first to notice this, and calls attention to this in the volume mentioned. He noticed also that the surface of many of the rocks were not only polished, but blackened. This he attributed to organic matter, dried and afterwards worn and polished by the drifting sands.

He observed also that some of the erratic bowlders were limestone and fossiliferous; they were undoubtedly carboniferous. Cyathophyllæ and nummulites were found near Yuma. There are portions of the great desert where water-rounded pebbles lie on the surface entirely free from sand or loose gravel; they have become imbedded in the tenacious clay and now lie a natural mosaic pavement.

Professor Blake says: "No part of the desert lies much above the sea level, and there is great reason to believe that much of the surface north of the emigrant sand from the Gila is below it." This has since been found to be true. The water of the ancient lake must have contained a large quantity of carbon of lime, as shown by deposits of calcareous sinter or travertine. Near Pilot Knob the washed bowlders have become a conglomerate, being, as observed by Professor Blake, imbedded in a calcareous paste. Many of the bowlders lying on the desert have a slight incrustation of lime. All over the desert may be seen sheets of travertine from an inch to two feet in thickness. A sample taken from any portion of the desert sand or soil will effervesce if treated with hydrochloric acid. The travertine strongly resembles the thinolite found in the alkaline lakes in the great basin, so carefully described in the United States surveys of the fortieth parallel.

The following analysis was made in the laboratory of the State Mining Bureau by Mr. Edward Booth, a sample of which has been placed in the State Museum and numbered 2443 in the catalogue:

Water	2.35
Chloride of sodium	1.26
Sesquioxide of iron	2.16
Sulphate of lime	1.79
Carbonate of lime	78.10
Carbonate of magnesia	2.84
Silica, clay, etc	9.97
Total	98.47

A section of an iron pipe may also be seen in the State Museum (Catalogue No. 2264), laid at Frink's Spring, in the Colorado Desert. The pipe is nearly filled with aragonite, containing magnesia, sulphate of lime, oxide of iron, and silica. This is another evidence that the forces which formed the travertine are still active.

I submitted a sample of the sandy soil taken from near Volcano Station, to chemical and physical examination, and found it to be highly calcareous. From a portion all the shells were picked out by hand, and were found to be 1.96 per cent. A second portion, including the shells *Tryonia clathrata*, was treated with hydrochloric acid. The action was so energetic that it was difficult to prevent overflowing in a capacious beaker. In the solution, iron and lime were found, traces of other substances being disregarded. The amount dissolved was 10.6 per cent. Another portion was treated with water; after boiling in hydrochloric acid, it formed a muddy mass; washed on a fine sieve, a portion of sand remained, which was weighed, and found to be 46.6 per cent. This sand, under the microscope, was seen to be rounded; all the angles were rounded and worn. It was principally quartz, with flakes of mica. The above results tabulated are as follows:

Shells	1.96
Solution in hydrochloric acid, less the shells	8.65
Coarse sand	46.60
Clay, fine sand, etc. (by difference)	42.79
Total	100.00

Professor Blake examined the sands of the desert at Alamo Mocho carefully, and found nearly all the grains were rounded. He also found a large quantity of silicified wood lying loose on the surface near this point. He traveled along the west side of the desert, and did not see the salt sink, or lagoon, but mentions it in his narrative, stating that the exact locality was unknown. He alludes to the possibility of obtaining water by means of artesian wells, and gives a list of all the watering places known at that time. Since his writing the land has been surveyed, and the Southern Pacific Railroad carries in safety and without inconvenience, thousands of passengers across this desolate region, and all former terrors, except an occasional sand storm, are among the things of the past.

As we pass over the surface of the desert it seems level to the eye, but by the aneroid, shows that it is gently rolling or undulatory, and that there is a gradual depression toward the great salt bed and a gradual uprise to Fort Yuma. At the junction of the Gila with the Colorado the landscape is utterly desolate.

Among the curious features of the Great Colorado Desert the sandstorms may be mentioned, which are much the same as those so often described by travelers in the Desert of Sahara. When there is a violent wind blowing the dry sand rises in clouds, which darken the sun and render the scene gloomy and actually frightful. All landmarks are shut out from view, and without a compass it is impossible to proceed. As the storm increases the sharp sand and small pebbles are blown with such force that it is impossible to face the wind, in which case the only resource is to halt and make the best of the situation until the storm abates. It is generally possible to find one of the ravines, already described, before the storm reaches its heighth, which will serve as a partial protection, but under the best of circumstances a sandstorm on the desert will prove a very disagreeable experience to the traveler.

The idea of irrigating the Colorado Desert seems to have suggested itself almost with its first discovery. Dr. O. M. Wozencraft proposed to cut a canal to the Colorado and bring the waters of that river to the dry but rich soil of the desert. The subject was presented to Congress in the year 1858–9. This plan is far from being visionary, and there seems to be no reason why it should not be successful. I have had the good fortune to study the ancient canals made by the prehistoric inhabitants of the Gila Valley in Arizona. The ancient people built their canals with an engineering ability of which the present race would not be ashamed. Without modern appliances they conveyed water from the Gila River, near Florence, to the mesa at Casa Grande, at which point they constructed extensive reservoirs. They probably used vessels of earthenware instead of wheelbarrows, and carried them by hand, full of earth, to the embankments, which I think accounts for the vast quantity of broken vessels scattered over the plain. Artificial irrigation has been very successful at Phœnix, also in Arizona, at which locality I have seen a large extent of country reclaimed and covered with luxuriant wheat fields and trees. The accident of the overflow of the Colorado River in the year 1840, which gave birth to the stream now known as New River, has demonstrated the fact that the desert land only requires water to make it as productive as the valley of the Nile or the Mississippi.

It is a great mistake to suppose this now desert land to be worthless. San Diego County has many resources which will make the county prosperous for years to come. The mineral resources are but little known or appreciated. Salt is known to exist in vast quantities in the sink of the ancient sea, and borax, sulphur, and nitrate of soda are likely to be found, while the carboniferous formation made known by Professor Blake leads to the hope, and even the probability, of true coal being eventually discovered. There are also known mines of great value. The gold mines of Carga Muchacho, which lie about twelve miles west of Fort Yuma, have been worked successfully, as shown by the reports of the Yuma Mill and Mining Company. Fourteen thousand tons of the ore were worked in the mill at El Rio, on the Colorado River, five miles west of Yuma, and on the Southern Pacific Railroad, yielding $167,000, as stated by Mr. Sublett. Specimens of this ore have been placed in the State Museum.

What is known as "New River" had no existence before the year 1840, when it broke away from the Colorado, and for a time partly submerged the desert. For several years after, a chain of lagoons remained. The same thing has probably occurred many times in the history of the desert.

The following extract from the San Diego Herald of a recent date gives a good description of this portion of the desert which I have not visited. It also mentions a deposit of sulphur, which promises to be of considerable importance:

The New River country begins in San Diego County, at the Indian Wells, on the road from San Diego to Fort Yuma, and extends in a southwesterly direction to the Colorado River, a distance of about eighty miles, and varying in width from ten to twenty miles. The land is all made from sediment settled during the floods, which occur usually each year. The soil is rich—very rich—and vegetation springs from it with a luxuriance unequaled except in the most favored climes. The valley having been made of sedimentary deposits during overflows, is almost perfectly level, except in the immediate vicinity of the channel or bed of the river, and therefore can be easily irrigated and worked by side streams, ditches, or canals from the Colorado River.

The stream of water comes from the Colorado River at a point where the sand has accumulated to such an extent that the river, departing from the old bed, wanders off into and over this great plain. It is a side stream, with no outlet, running nearly north, and gradually sinking as it wanders, until it is finely lost in the desert. When the snow melts at the head of the Colorado River, the whole of this vast country becomes flooded, and forms a lake of fresh water, eighty miles or more in length, and from ten to twenty miles broad. The inundation, however, is never to a great depth, on account of the great extent of level country lying on the Colorado River at the point from which New River debouches, the necessary rise being but a few feet above the sand bank or bar, through which the Colorado flows at this point. It is said that at this place but little labor would be required to make canals and ditches, by which the supply of water from the Colorado could be so regulated and controlled that miles of the land could be flooded and drained with more perfect system and certainty than the best rice lands of the Carolinas. Hundreds of miles of this land could be subjected to the best system of irrigation, and thousands of homes could be opened up to the most lucrative branches of agriculture.

The climate is semi-tropical, and rice, sugar, cotton, the orange, olive, and banana, can be grown to perfection. On the west side, the Cocopah mountains protect the valley from the winds from the Pacific. They gradually rise out of the so called desert, near the Indian Wells, and disappear in the mud flats and sand banks near the mouth of the Colorado. By a similar outlet to the Colorado, the west side of this range of hills (the Cocopah) is also flooded, but of the character of the country our informant could give us no description.

There are no settlements in this valley of which Mr. Tannahill has any knowledge. He saw none. In fact, he saw nothing but Indians, with a few horses, but no cattle. They were friendly, accepted gifts of flour and provisions, and seemed pleased at their presence. Many of them had never seen a wagon before, and showed much wonder at this simple piece of mechanism.

On each side of the river the grass grows luxuriantly—the green grass spreading out two and a half miles, at the narrowest point, on each side the whole length of the valley. Near the Indian Wells, some parties are now busily engaged in making hay; and they intend getting machines for cutting a large quantity. Though there had never been a wagon through the country before, Mr. Tannahill had no difficulty in making a good road, and reaching the mine in a little over a day's drive from the Fort Yuma road. Deer, antelope, and quail, are found in abundance, and millions of carcasses of little fish are scattered over the ground, having been left by the retreating or sinking waters. The sulphur "mine" rises abruptly to the height of fifteen or twenty feet, and then gradually rises into a hill—the face now exposed being about two hundred and fifty feet in length—the top is covered with a light substance resembling fine ashes. The hill of sulphur is so solid and entire that it is picked off with some difficulty with picks and crowbars. The sulphur looks almost exactly like the ordinary rolls of sulphur purchased in stores—a shade lighter in color—and an analysis shows it to be sulphur and alum. We have seen large quantities of it. The mine is situated in Lower California, about fifty miles below the boundary line between the United States and Mexico, and about eight miles west of New River.

The Texas and Pacific Railroad will run directly through the northern portion of this valley, or, may be, just a little north of it. At no distant day the whole of it will be easy of access from the Pacific. We call the attention of capitalists and agriculturists to the spot, and promise that they will find the above description in nowise an exaggeration.

The following letter, published in the San Francisco Evening Bulletin, bearing on the natural resources of San Diego County, both vegetable and mineral, is relevant:

Since it is a demonstrated fact that San Diego is to have two competing railroads, one controlled by the Atchison, Topeka and Santa Fè and Atlantic and Pacific interests, and the other by the Southern Pacific, a great interest has sprung up in all parts of the country, and particularly in California, as to the immediate future of this remote corner of the State.

The writer, having recently returned from a tour of observation, taken with a view of gaining information in regard to this place, presents to the readers of the Bulletin a few facts which will be of interest to all those who look with favor upon the development and improvement of all portions of this great commonwealth.

San Diego may be reached from San Francisco in two days by rail, via Los Angeles to Santa Ana, and thence by stage about 100 miles, at an expense of $40; or by sea in three days, at an expense of $15. The most pleasant trip, however, is to leave San Francisco the day after the departure of the steamship, by rail, via Los Angeles, to Wilmington, where the traveler overtakes the steamship in the evening, and arrives at San Diego about daybreak next morning. This shortens the trip to a little more than a day and a half; but with a fast line of through steamships, the journey ought to be made in thirty hours, and will be as soon as the trade and travel will warrant the expense of faster boats.

One of the first things which attracts the attention of the visitor is the beautiful Bay of San Diego, which is fourteen miles long by one to three miles wide, and of which Professor George Davidson, of the United States Coast Survey, says: "Next to San Francisco, no harbor on the Pacific Coast of the United States approximates it in excellence. No rocks have been discovered in the bay or approaches, and the position of the bar with relation to Point Loma is such that there is less swell on it than any other bar on the coast. Large vessels can go about seven miles up the bay with an average width of channel of 800 yards between the four-fathom lines, at low water." There is twenty-three feet of water on the bar at mean low tide, one foot more than at New York, five more than at Boston, and four and a half more than at Philadelphia, and ships come in and go out at all times of the day and night without a pilot, and in perfect safety.

The business center of the city is situated opposite the narrowest portion of the bay, and is one of the prettiest sites for a town on the coast, having just slope enough from the foothills to give excellent drainage.

The soil is a rich sandy loam, and contains sufficient clay to make it pack nicely, but not enough to hold the water. The consequence is, that without grading they have good hard streets to travel, and absolutely no mud.

The climate is a never-ending subject of discussion, the people claiming that it has no superior in salubrity, equability, and healthfulness, and that they enjoy entire freedom from malarial and pulmonary diseases. An examination of the reports of the United States Signal Service on Fifth street, San Diego, shows that the temperature seldom goes below forty-five degrees or above seventy-five degrees, and that the average mean is about sixty degrees. The total absence of extremes of heat and cold will eventually make this place one of the most noted sanitariums in the world.

People from the East, looking for a more genial climate on this coast, hundreds in our overcrowded cities, and the constantly moving tide of emigration to new fields of enterprise and industry, will very naturally ask in regard to this country: How do the people gain a livelihood? What are its principal resources and productions? In answer, we would say, that quite contrary to the very erroneous impression generally prevailing, that nothing can be produced but cattle, sheep, and honey, we find here some of the most productive valleys in the State.

The most important grain-growing valley is the Cajon (pronounced ca-hone), where several thousand acres of wheat, barley, and other cereals are harvested yearly. To give the reader an idea of the wonderful productiveness of this section in favorable years, we will cite but one instance. Uriah Hill, one of the leading farmers of the Cajon, had his place mortgaged for $19,000 to Major Chase, and considered himself hopelessly involved. He asked Mr. Chase to take the place, as he saw no way of paying the debt. The Major insisted on his retaining the ranch another year, and the result was, that last season being a good one, Mr. Hill sold his wheat crop for enough to pay off the entire indebtedness and leave him a balance of $1,500. This year he has 1,400 acres sown, and the season has opened more auspiciously and promises even better returns than last.

Besides being a good stock and grain country the greatest part of the land for thirty or forty miles back from the coast line, particularly the mesa, is most admirably adapted to the cultivation of all kinds of northern and semi-tropical fruits. W. H. Davis, who built the first wharf in San Diego thirty years ago, claims that it is the natural home of the grape, and that when properly developed it would be one of the best wine counties in the State; while Dr. George R. Ghiselin, an old Virginian, and a man well known on this coast, says that the soil and climate of portions of the county cannot be surpassed, even in Cuba, for the cultivation of tobacco.

On the sea shore, about ten miles north of San Diego, a seam of coal from three to five feet thick can be traced for a long distance. Major John G. Caperton, an Oakland capitalist, has secured a lease of these pueblo coal lands of San Diego, and has commenced opening a mine. The coal is a brown lignite and of a quality that does not admit of a doubt as to its utility. It is near the line of the new railroad, which may be reached by a level tramway about a mile distant.

The development of these mines will have a very important influence in building up manufactures, particularly of cotton and woolen goods, the raw materials for which are marketed here in such quantities.

We append a table of the chief exports from San Diego by steamer, for the year 1880, carefully compiled and furnished by Douglas Gunn, of the San Diego Union:

Wheat, pounds	3,119,410
Barley, pounds	44,000
Honey, pounds	1,191,800
Wool, pounds	1,217,557
Shells, pounds	649,437
Dried fish, pounds	645,537
Hides and pelts, pounds	151,854
Salt, pounds	309,000
Potatoes, pounds	312,721
Onions, pounds	13,347
Ores, pounds	37,864
Flaxseed, pounds	5,649
Beeswax, pounds	28,000
Sealskins, pounds	16,380
Butter, pounds	4,921
Lard, pounds	2,755
Bacon, pounds	3,528
Tallow, pounds	10,500
Eggs, dozen	9,625

Besides the foregoing, the exports embraced saddlery, leather, hives of bees, orchilla, mohair, trees and plants, oranges, lemons, limes, olives, grapes, apples, dried fruits, raisins, turkeys, chickens, etc. The above list does not include about 300,000 pounds of wool exported from the northern part of the county, nor but a fraction of the wheat and barley crops, which amount to about 27,000,000 and 6,000,000 pounds respectively. There is also 135,000 pounds of honey not yet forwarded, making the total crop for the year 1,326,800.

DIAMONDS IN CALIFORNIA.

The name diamond is a corruption of "adamas" or "adamant," derived from two Greek words, meaning "I conquer,' referring to its excessive hardness.

The early history of the diamond is obscure. There seem to have been stones of quite different nature known to the ancients as "adamas." Pliny says: "Adamas is a mineral which for a long time was known to kings only, and to but few of them. The ancients supposed that adamas was only to be discovered in the mines of Æthiopia, between the temple of Mercury and the Island of Meroe, and they have informed us that it was never larger than a cucumber, or differed at all from it in color."

It is very certain that Pliny knew but little of the matter, for he describes six varieties, all of which, according to his description, possessed properties not found in the diamond, but he becomes absurd when he says that the diamond, "which resists every force of nature, is made to yield before the blood of a he goat." To those who desire to verify this reaction he gives the following advice: "The blood, however, must be warm; the stone, too, must be well steeped in it, and then subjected to repeated blows."

Allusions met with in their ancient mythology lead to the supposition that the Hindoos were in possession of gems and held them in high estimation.

According to Jewish history as set forth in the Bible, the diamond was one of the twelve gems set in the breastplate of the high priest. But to my surprise I find that Josephus denies this indirectly. As the discrepancy is remarkable I have given both authorities:

	Bible.		Josephus.
1	Sardius.	1	Sardonyx.
2	Topaz.	2	Topaz.
3	Carbuncle.	3	Emerald.
4	Emerald.	4	Carbuncle.
5	Sapphire.	5	Jasper.
6	Diamond.	6	Sapphire.
7	Ligure.	7	Ligure.
8	Agate.	8	Amethyst.
9	Amethyst.	9	Agate.
10	Beryl.	10	*Chrysolite.*
11	Onyx.	11	Onyx.
12	Jasper.	12	Beryl.

It will be seen that in the list given by Josephus that the arrangement is different, and that the chrysolite replaces the diamond. According to the Bible, the diamond was one of the precious stones worn by the king of Tyre.

History shows that the ancients attributed great medicinal powers to gems. They were worn also as a protection against all forms of evil, some in a vague general way, while others were regarded as antagonistic to special diseases or accidents. Pliny claims for the diamond that it will "overcome and neutralize poisons, dispel delirium, and banish groundless perturbations of mind." Less than a century ago diamonds were borrowed from rich families to act as a cure for certain diseases. It is said that to prevent them being swallowed by the patient they were secured by a string when placed in the mouth.

Plato and Pythagoras must have known something of gems and crystals, as they have beautifully written how "Nature, in the dark recesses of the earth, occupies her time in working out geometrical problems."

It is a curious historical fact that when, during the French revolution, the diamonds of the rich were given to the people, it was found that many of them were imitation.

Until quite recently the chemical composition of the diamond was unknown, nor could it be cut by any means known. It was worn as found, and was consequently inferior in appearance to those we see in our day. As soon as its chemical nature was discovered, attempts were made to produce it artificially in the laboratory, but up to the present day with only partial success.

The first diamonds came from India. The famous mines of Golconda are situated between Hydrabad and Masulipatam. Other localities in India have produced large quantities. It is said that Sultan Mahmoud, when he died, left 400 pounds of diamonds. These diamond fields are now exhausted and seldom produce any stones of value.

Diamonds were discovered in Brazil in 1728. They had always been thrown aside as useless in gold washing, until one who had seen this gem in the rough state quietly collected a large quantity of them, from the sale of which, in Portugal, he realized a fortune. They are found in an alluvial soil, in the district of Cerro di Fria, Minas Geraes, San Paulo, and in other localities. Those Californians who have visited Rio Janeiro will remember the gorgeous display of diamonds in the shop windows—the product of these mines. It is said that Brazil has produced over two tons of diamonds. When the Brazilian diamond fields were opened, it was not believed in England; but it was thought that Indian diamonds had been sent to Brazil, and from thence to England. The mines of Borneo have produced but few large diamonds, but great quantities of small ones. The amount of annual production credited to that island is 2,000 carats=1.1428+ lbs. avoirdupois. There have been two panics in the price of diamonds; the first when it was known that Brazil was producing large quantities of this gem, and the other at the time of the French revolution. At these periods the prices of diamonds fluctuated in the strangest manner.

The discovery of unusually large deposits of diamonds in South Africa in the year 1867 caused considerable commotion in the diamond trade. In 1880 the gross weight of diamonds that passed through the Post Office at Kimberley was 1,440 pounds and 12 ounces avoirdupois, the estimated value of which was $16,000,000. At the end of 1880, 22,000 blacks and 1,700 white men were employed in the diamond fields of South Africa; 250 men were engaged in diamond mining on the Vaal River the same year.

From Kimberley and Old De Beer's mines alone diamonds to the value of 3,000,000 carats are annually raised. Two other mines produced 300,000 carats in 1880. The following table gives the shipments for four years, and the value:

Year.	Weight—Pounds, Avoirdupois.	Value.
1876	773	$8,000,000
1877	903	10,000,000
1878	1,150	13,000,000
1879	1,174	14,000,000
Totals	4,000	$45,000,000

According to Professor Tennant, ten per cent. of the Cape diamonds are first class, fifteen per cent. second class, twenty per cent. of the third; the remainder being of the quality known as *bort*, and are useful only to cut other diamonds, and for glaziers' diamonds, rock drills, etc.

The diamond is pure carbon crystallized. Chemically it does not differ from charcoal, and is also nearly identical in composition with graphite. It is the hardest of all known substances. Its specific gravity is 3.529 to 3.55. Diamonds are not always colorless, and this fact renders their determination difficult. They are sometimes tinged yellow, red, orange, green, brown, blue, rose-red, and often black. When the color is decided they are more valuable than when limpid. When light colored, they are said to be "off color." The fracture of the diamond is four-fold, parallel to the faces of the octahedron. The fragments are octahedral or tetrahedral. It strikes fire with steel, the surface is often rough or striated, sometimes covered with a scaly crust. The touch of the diamond is cold. When the cut gem is breathed upon the luster is lost for a moment, when defects are seen.

Diamonds found in river beds are generally in amerphous, while those found imbedded in the formations peculiar to their locality are covered with an earthy pale gray, yellow, or rose-red coating. The texture of the diamond is lamellar.

The diamond exhibits a beautiful play of colors in the direct rays of the sun or bright artificial light. To its luster has been given the name of "diamond," or "adamantine luster." Its refraction is simple, but it possesses this power in a higher degree than most other minerals of equal specific gravity. In consequence of its extreme hardness, it can only be cut by its own powder. The common saying, "diamond cut diamond," is exceedingly expressive. When rubbed it becomes positively electrical, even before being cut, in which it differs from all other gems. When, after exposure to direct sunlight, it is suddenly placed in darkness, it shows phosphorescence, and the evolution of light continues for some time. It is not acted upon by any acid or alkali, but it may be consumed and completely oxidized to carbonic acid at a high heat in the atmosphere. It is so difficult to burn that the ordinary blowpipe flame has no effect upon it. It may be heated to whiteness in a closed crucible without change, but it begins to burn in a muffle at the melting point of silver. At a high heat with nitrate of potash it is rapidly decomposed. A diamond may be burned away on a piece of platinum in the flame of a powerful blast blowpipe.

Sir David Brewster found cavities in the Kohinoor, and other large diamonds, with the microscope. Black diamonds he found to be opaque from a multitude of such cavities. One large diamond having a black spot in it was cut in two, and the defect was found to be vegetable mud inclosed in the crystal.

Miners are generally not familiar with the appearance of diamonds in the rough state, and would most likely mistake them, if found, for chalcedony or some similar mineral. If in crystal form, it would be to them a crystal only—interesting for the moment, to be soon thrown aside as useless. A case has been mentioned in which a beautiful crystal, supposed to be a diamond, being found in some placer mine in California, was put to the following test: It was placed on an anvil and struck a heavy blow with a sledge hammer, it being assumed that the diamond, being the hardest of known substances, could not be broken. This idea is more ancient than is generally supposed. The statement has been made by Pliny, but it is doubtful if he ever made the experiment himself. In speaking of adamas, he says that it cannot be crushed, but would split hammers and anvils in the attempt. It is certain that this is a mistake. The diamond can be split on the edge of a knife, and even a light blow with a hammer might destroy the most costly gem.

The diamond is supposed to be of vegetable origin, and is believed, by those who have studied it carefully, to be produced by slow decomposition of vegetation or bituminous matters. It is generally colorless, but always transparent (except in case of the black diamond, which is opaque), generally crystallizes in octahedrons, but often found in rounded masses, occasionally in curious, irregular, concretionary forms, like chalcedony, or semi-opal. Generally the faces of the crystals are curved; sometimes they take a nearly spherical form, having forty-eight faces.

The diamond crystallizes in the isometric system. Sometimes crystals show the impression of other crystals upon their faces. The Indian diamonds are generally octahedral; those from Brazil dodecahedral.

It requires practice to judge of the diamond in its rough state. A rough diamond of the first water would be hardly recognized by the uneducated eye as a valuable gem. In describing the diamond, many of its characteristics are visible only in its cut state. Half the stone is sometimes cut away before a perfect gem can be produced. The diamond washers of Brazil rub the stones together and produce a peculiar grating sound, by which they claim to judge of their value.

There is a peculiar appearance about a rough diamond which can hardly be described. No written description would convey to the reader a correct idea of what they are exactly like. It is easy to say that they possess a peculiar luster, like spermaceti, but who would feel certain of the identity of a diamond from such a description? Once seen, this peculiar luster becomes impressed on the mind. To educate the eye, models of rough diamonds are made at Amsterdam for the use of prospectors, and they are found extremely useful.

The diamond has been found massive in Brazil. In this form it cuts glass, scratches quartz and topaz, has a specific gravity of 3.27 to 3.52, and is nearly pure carbon, being completely consumed in oxygen gas. It occurs in kidney-shaped, irregular masses, exterior generally black, sometimes resembling graphite, has a somewhat resinous luster, and sometimes takes very singular forms. The outer coating black and resinous, interior crystalline, vitreous and lamellar, like the diamond. It has been used in powder to cut other diamonds. The diamond cutters call this variety "cheese stones."

Black diamonds are sometimes called "carbonate," or "carbonado." They are even harder than the crystallized stones. They are found in mammillary masses, sometimes 1,000 carats in weight.

Newton first suggested the probability of the diamond being combustible. He was led to this opinion by observing its power of refracting light so strongly. It was in 1675 that he advanced this theory. In 1694, the members of the Academy of Florence succeeded by means of powerful lenses in consuming diamonds. Lavoisier and others proved that the diamond was not evaporated, as supposed by the Academicians, but was actually burned. Lavoisier found by his experiment that if air was excluded, no decomposition took place. He burned diamonds in close vessels with powerful burning glasses, and found that carbonic acid was produced, and discovered and announced the striking similarity between their nature and that of charcoal.

Sir George McKenzie found that they could be consumed in a common muffle. In 1797, Mr. Tennant made a decisive experiment by placing a diamond, the weight of which was noted, into a tube of gold with nitrate of potash. The tube was subjected to great heat, which was maintained some time. The diamond was oxydized at the expense of the nitre. The carbonic acid evolved was conducted into lime water, and the precipitated carbonate of lime weighed. It was found to be equivalent to carbon, equal to the weight of the diamond consumed, proving it to be pure carbon.

The diamond may be burned in oxygen by suspending it in a glass globe filled with that gas. The stone is held suspended in a coil of fine platinum wire, which is made redhot by passing a current of electricity through it. The diamond soon begins to burn, and is wholly consumed. Lime water or baryta water is then shaken in the globe, when a precipitate of carbonate of lime or baryta is formed, which dissolves with effervescence in dilute acids.

The diamond can be fused by the action of a powerful galvanic battery. Experiments made with a view to prove this resulted in the fusion of six small diamonds in seven and one half minutes. On exposure to the greatest heat, they first changed to charcoal, then to graphite, after which they fused into globules. These experiments led to the conclusion that the diamond is not produced by the action of intense heat on vegetable or organic substances, which is a favorite theory. The diamond is a non-conductor of electricity. After a great fire in Hamburg, diamonds were sold for small sums, which had turned black, but, upon being repolished, they became again as brilliant as ever.

The diamond is generally, if not invariably, found associated with a peculiar granular laminated quartz rock or sandstone, to which the name of itacolumite has been given. According to Dana it owes its lamination to a little talc or mica. This rock is found in Brazil, in the Urals, and in North Carolina and Georgia. A specimen from the latter locality may be seen in the State Museum—catalogue number 1371. It is five inches long, and so flexible that it may be bent a quarter of an inch without breaking. As far as I know this rock has not been found in California. Professor Whitney does not mention it in either his volume on general geology or his auriferous gravels. I have looked for it at the localities of the diamond that I have visited, and have made many inquiries, but as yet without success. Mr. Carpender mentions it in his letter, and the name appears in the quotation from Mr. Attwood's paper, but both statements require verification.

Diamonds are found in Brazil, in beds of gravelly conglomerate called "casclaho," frequently cemented by oxide of iron, and from description, resembling some of the cemented gravels so common in the hydraulic and drift mines of California. In such an iron cemented formation a negro slave in Brazil found a bed or cluster of diamonds—probably in place—which sold for $1,500,000. Shortly after the discovery of the African diamond fields, Mr. Reily, who returned from thence, brought to California samples of the gravels associated with diamonds, which are probably preserved in some collection of the State.

Platinum, gold, rutile, zircon, quartz, feldspar, brookite, diaspore, magnetite, and yttria minerals are almost always the associates of the diamond. Some platinum has been found in Georgia and North Carolina, where a few diamonds have also been found.

Humboldt, in one of his works ("Essay on the Bearing of Rocks"), calls attention to the fact that gold, platinum, and diamonds are associates in various parts of the globe—in some places, gold, platinum, and palladium; in others, gold, platinum, and diamonds. In the River Aboite, in Brazil, diamonds are found with platinum; near Tejuca, with platinum and gold. These facts awakened in him the strongest hope of finding diamonds in the Ural, where the association of these metals is known to exist. When he arrived at any of the works, he caused the gold sands to be examined microscopically, and if gold and platinum were found, he directed the workmen to look carefully for diamonds. These examinations led to the discovery of microscopic crystals, previously unknown in the gold sands of the Ural—such crystals, as in Brazil, occurred with gold, platinum, and diamonds.

The truth of Humboldt's theory as to the existence of diamonds in the gold sands of the Ural was proved by the subsequent discovery of a valuable stone by Paul Popoff, a boy of fourteen years, to whom belongs the honor. It was at first supposed to be a topaz, but a young Freiberg student, a Mr. Schmidt, who had the necessary instruments to test the hardness and specific gravity, identified it as a true diamond. Two others were soon afterwards found, the third being larger than both the others, followed by systematic search, which has since produced many valuable stones.

Diamond cutting not only requires great skill and judgment, but also the outlay of considerable capital. The largest establishments for this branch of industry are in Amsterdam. In the year 1872 I visited the works of M. & E. Coster, in that city, and saw the whole operation. The building is a large brick structure, every part of which is devoted to some branch of the trade. A beautiful and powerful engine in the basement drives the machinery. Vertical shafts pass up to the top of the building, and from these the grinding discs are geared.

I was first shown the room where the diamonds are kept for safety, and had the opportunity of seeing some fine stones. From this room I was shown to another where the diamonds are split. This is a curious and delicate operation. Only workmen of great experience are allowed to attempt this work.

The rough diamond is taken up by one of the workmen in this room, who studies it carefully, calculates mentally what parts can be removed without detracting from the value of the stone, keeping in mind the rule, that the value of a rough diamond is only that of the largest doubly truncated perfect octahedron that it will make. All excess must be removed. It is a great advantage to split off fragments, for the double reason that the larger fragments may be cut with profit into small stones, to set around opals or pearls, and because it is a great economy of time, as the grinding down of the stone is a slow and tedious operation. It sometimes becomes necessary to remove flaws by this operation.

The workman is well aware of the fact I have already stated, that the cleavage of the diamond is fourfold, and takes of it every advantage. It is astonishing to witness the skill with which the operation is performed. A workman cements the stone to a piece of compact wood by means of strong cement, leaving the portion to be removed exposed. To this end he fashions the cement with his fingers, while still soft, then with a fragment of another diamond he makes a deep scratch along the line of cleavage. Then, after wrapping the stone in loose folds of cloth, he applies a steel rule or knife, and with a gentle and skillful blow with a light rod of steel, he breaks off the portion he wishes to remove with unerring certainty.

From the hands of this workman the stone passes to another in a second room, who continues the operation by cementing it again to the end of a stick, and taking another diamond of equal size, also cemented in the same manner to a stick, he rubs the two together until he produces the proper facets on each—each grinding the other down. The workman to whom this operation is intrusted wear heavy leather gloves. The powder resulting from the abrasion is carefully collected in a box, in which oil is kept, which collects the dust, and prevents it from being blown away. When sufficient has collected, the oil is burned away, leaving a gray powder called "bort," which is more finely powdered, and used to polish other diamonds. During the operation of grinding, the workman frequently touches the stone to his tongue, to see how the operation progresses; first, however, removing any adhering diamond dust with a camel's hair brush. This work does not form all the facets of a perfect stone.

The next and last operation is that of polishing the rough cut stone and of cutting away some of the edges, producing a new set of facets, due to a perfectly cut brilliant.

The polishing is done on discs of iron or steel. These wheels are about three feet in diameter and rotate horizontally. They move with great velocity, making 2,000 revolutions in a minute. They are so true, and run so smoothly, that at first glance they seem like stationary tables, sustained by the vertical shafts. It requires some skill and labor to prepare the surface of these discs to render them suitable for receiving the diamond powder. Stones of varying fineness are used in such a manner as to leave stria on the surface, something like that of the burr millstone, but very much finer. A mixture of diamond dust and olive oil is then placed on the face of the disc, which is called a "skaif." The workman then takes a brass tripod, of which one arm is longer than the others; in the end of this longer part there is a socket, which he fills with melted solder, into which, as it cools, he imbeds the stone, leaving the face only exposed which he wishes to polish. When the solder is perfectly cold and hard he turns the stone down on the revolving plate, allowing the shorter arms to act as a claw to hold against the friction of the wheel. He then puts weights on the end of the tripod above the stone. These are heavy or light as the face is large or small.

The Amsterdam establishment employs from 500 to 600 persons. An establishment for diamond cutting has lately been started in New York, under the name of the New York Diamond Company. For many years diamonds have been cut and polished in Boston, and quite recently the English have turned their attention to the art they once excelled in.

There are three modes of cutting the diamond; the rose, the brilliant, and the cabochon. The shape of the rough stone and the taste or want of taste of the owner determines which style shall be adopted. The art of cutting diamonds by their own powder originated with Louis Berghen, of Bruges, in the year 1476. At first the style was a flat table with facets on the edges. The brilliant was invented during the reign of Louis XII. Cardinal Mazarin is said to have been the first who had diamonds cut in that form.

The cutting of the brilliant is governed by certain rigid rules, the slightest deviation from which produces an imperfect gem. David Jeffries, who published a treatise on diamonds and pearls in London in 1750, a copy of which may be found in the library of the State Mining Bureau, gives the rules in detail, illustrated by diagrams. The work also gives tables for valuing diamonds from one to one hundred carats, increasing by eighths of carats.

The stone is first reduced to a perfect octahedron, in which all the axes are equal. Setting one axis vertical he divides it into eighteen imaginary equal parts. The edges at which the pyramids meet is called the "girdle." The upper part of the octahedron is cut off at the fifth division from the top and parallel to the girdle, forming the face which is called the "table." The bottom part of the stone is then cut off at the first division, leaving a small face called the "collet," the remainder is then a perfect square brilliant. The edges and solid angles are then cut into a number of facets and highly polished, and the brilliant is finished.

Sometimes to make a diamond appear larger the angle of the crystal is made greater than ninety degrees. Such a stone, wanting in depth, is deficient in brilliancy, although appearing larger than a perfectly proportioned stone. Such diamonds are called "spread brilliants." In other cases, for certain reasons, the angle is less than ninety degrees. The table is then smaller than it should be, and is unsatisfactory to the educated eye. Jeffries' tables for valuing stones is used as follows: Suppose the reader has a diamond which weighs four and one eighth carats, and wishes to ascertain if it has been properly cut: With a pair of small calipers he takes the width of his diamond and compares it with the model of a brilliant of the same weight in the table. Then with the calipers he takes the thickness of the stone, from table to collet, and compares it with the bar below the model. Lastly, he measures the size of the collet; if the diamond is badly cut the defect will be seen at once. These tables have been copied ever since, and may be found in works on diamonds and precious stones.

Diamonds are valued according to weight, purity of color, and freedom from defects, etc. Much depends also on the state of the country where they are for sale. When times are prosperous and money plenty, they will find a readier sale than when the reverse is the case. There is no rule which gives the absolute value of first-class diamonds. But the trade is governed to a great extent by the formula devised by Jeffries, to whose work I have before alluded. His tables assume that diamonds increase in value proportionally to their increase in size. At the time his tables were calculated it was assumed that rough diamonds, both good and bad, averaged ten dollars (two pounds sterling) per carat. (One carat equals four grains.) To ascertain the value of any rough diamond he multiplied the square of its weight by the value of one carat. Thus, if a rough diamond weighed five carats, its weight would be 5×5×$10= $250.

A cut stone was calculated differently. It was taken for granted that a rough diamond loses half its weight in cutting, therefore the calculation was made on the value of a rough stone of double the weight; for example: for a cut stone of five carats, 10×10×$10= $1,000, and to this price was added the cost of cutting. The best glazier's diamonds are worth fifty dollars per carat, but few being fitted for that purpose.

The value of fine diamonds has largely increased since Jeffries' time (1750), and in 1865 a diamond of five carats was worth in London £350, or $1,750, reckoning the pound at five dollars. The same authority from which I take this valuation says that the stone must be free from the faintest tinge of color of any sort, from any flaws, specks, marks, or fissures of any sort, must be bright and lively and free from what is technically called "milk" or "salt." The stone must also be cut in perfect proportion, according to the rules before given. This author also says that it is impossible to calculate the value of a stone above five carats, as the price depends wholly upon supply and demand. When a diamond has a decided color it is called a fancy stone, and will bring a very high price.

Unfortunately, the temptation to produce large-surfaced stones at the expense of the rules of the true proportion is so great that perfectly cut stones are seldom seen. To own a perfect diamond is to possess a gem in a double sense.

The most valuable diamond found in the United States was discovered in 1856 on the banks of the James River, opposite Richmond, Virginia; its weight was 23.7 carats (ninety-nine grains).

REMARKABLE DIAMONDS.

A diamond over ten carats in weight is called a "princely" diamond; only one in about 10,000 can lay claim to this distinction. There are eight diamonds which, being of unusual size and splendor, are called "sovereigns." All of them are more than 100 carats in weight. The following is a list of the sovereigns, and the most celebrated of the princely diamonds known:

No.	Name.	Carats.	No.	Name.	Carats.
	Sovereigns.			*Princely Diamonds.*	
1	Braganza*	1880	9	Piggott	82¼
2	Mattam	367	10	Shah	86
3	Great Mogul	297$\frac{3}{16}$	11	Nassak	78⅝
4	Orloff	194¼	12.	Bryce Wright	66½
5	Florentine, or Toscanor	139½	13	Sancy	53½
6	Regent, or Pitt	136¾	14	Eugene	51
7	Star of the South	125	15	Hope-Blue	44½
8	Kohinoor	106$\frac{1}{16}$	16	Pasha of Egypt	40
			17	Cumberland	32
			18	Polar Star	------

There are others which could be mentioned, but the above table includes all those of special interest. A green diamond at Dresden weighs forty-eight and a half carats, and is said to possess remarkable brilliancy and beauty. The celebrated French blue diamond was lost in the revolution and never found.

The existence of diamonds in California was early known. In the Annual of Scientific Discovery for 1850, in an article quoted from Silliman's Journal, may be found a statement to the effect that the Rev. Mr. Lyman, formerly from New England, saw a crystal in California of a light straw color, having the usual convex faces, and about the size of a small pea. He saw the crystal but for a few minutes, and had no opportunity for close examination, but the appearance and form left little doubt that it was a true diamond. From that time to the present, diamonds have been occasionally found in localities where the formation is of a similar character.

Mr. W. A. Goodyear is quoted in Whitney's "Auriferous Gravels of the Sierra Nevada of California" as follows: "He saw a diamond in the possession of Mrs. Olmstead, at Dirty Flat, near Placerville, El Dorado County, which measured nine thirty-seconds of an inch maximum diameter, and weighed one and a quarter carats—5$\frac{61}{100}$ grains. It was found by Mr. Olmstead in cleaning up the sluices of the Cruson tunnel, Dirty Flat." The same stone is mentioned in Mr. Carpender's letter (No. 4).

At the McConnell & Reed claim, on the south side of Webber Hill, a diamond the size of a small white bean was found. This diamond was discovered a few feet above the bedrock. Mr. McConnell thinks on a previous occasion he had thrown away a diamond as large as the end of his thumb, in ignorance of its true character. Two other diamonds were found in another claim, also on the south side of Webber Hill.

Three or four diamonds were found near White Rock. Mr. Goodyear purchased a crystal of Mr. Thomas Potts. It weighed half a carat—two grains; had a slight yellowish tinge, and was found in washing the gravel which came from a tunnel driven into White Rock. (See No. 5 in Mr. Carpender's letter.) Near the same locality three diamonds were found in gravel by the Wood Brothers, in 1867. The largest was valued by a San Francisco dealer at fifty dollars. The same authority gives the following localities of California diamonds: Jackass Gulch, near Volcano, Amador County; Indian Gulch, Loafer

* Doubtful, thought to be a topaz.

Hill, near Fiddletown, Amador County; French Corral, Nevada County, one specimen weighing seven and one half grains.

Diamonds have been found at Volcano, in Amador County, in a peculiar volcanic formation, described by Professor Whitney as "ashes and pumice cemented and stratified by water." The crystals had the form of the icositetrahedron, with faces curved in the manner peculiar to the diamond.

A formation occurs at Cherokee, Butte County, above the bedrock, which has the appearance of being the same volcanic mud to which I have before alluded, and somewhat resembling the deposit at Volcano, which I have seen and examined. Strong evidence that the so called white lava was not an igneous flow, and that it was at one time soft and plastic, is shown by the leaf impressions (Museum specimen No. 4219), presented by Dr. William Jones, and obtained two miles from San Andreas, Calaveras County. If the "lava" had been hot, it would have burned the leaves before they could have made any impression, and if the formation had been at all indurated the leaves could not have imbedded themselves, as shown in the specimen. With all our investigation and theories, we have much to learn concerning the auriferous gravels of California, their interesting mineral associates, and the geology of their deposition and occurrence.

Knowing that diamonds had been found at or near Placerville, and not having time to visit the locality, I addressed a letter to Mr. A. J. Lowry, Postmaster at Placerville, asking information, and in due time received the following reply:

PLACERVILLE, September 12, 1882.

Henry G. Hanks, State Mineralogist:

DEAR SIR: Your letter of August nineteenth, to Postmaster Lowry, of this place, asking for information as to the finding of diamonds near Placerville, has been handed to me, with the request that I answer it.

In 1871, Mr. W. A. Goodyear, Assistant State Geologist, while examining the deposits of auriferous gravels in the ancient river bed, about three miles east of Placerville, found several specimens of itacolumite, and expressed the opinion that diamonds should be found in the gravels. I assisted him in searching for them, and we found several in the hands of the miners. Mr. Goodyear bought one of them as a geological specimen. None of the parties who had them knew what they were, but had kept them as curiosities. The gravel in the channel is capped with lava from 50 to 450 feet in depth. Of late years the gravel is worked by stamp gravel mills, and I know of instances where fragments of broken diamonds have been found in panning out the batteries.

I give you the names of the finders of several diamonds in this vicinity, namely:

Charles Reed, one.

Mr. Jeffreys, one.

Thomas Ward & Co., three—Two white; one yellow. One of these is now in the possession of Mr. Ashcroft, of Oakland, who had it cut in England.

Cruson & Olmstead, four—One of which Olmstead sold to Tucker of San Francisco. It measured nine thirty-seconds of an inch in diameter, was pure, and nearly round. I think he got about $300 for it.

Thomas Potts, one—Which he sold to Mr. Goodyear for fifteen dollars. It was small, and flawed.

Jacob Lyon, one—Light straw colored, about the size of a medium-sized pea; also, several fragments obtained from the tailings of a gravel mill at the Lyon mine.

A. Brooks, one—Small white.

F. Bendfeldt, one—Small yellow, weighs two grains. It passed through a gravel mill.

The diamond mentioned in your letter as being "found by a lady in a dump at the mouth of a shaft," was probably the one found by Mrs. Henderson, in some tailings that had been washed for gold.

Yours, truly,

W. P. CARPENDER.

Mr. Melville Attwood was among the first to predict the discovery of diamonds in California. The following is an extract from a newspaper article written by him in 1854:

I am anxious to call attention to the chance of finding diamonds in this country, and the likelihood of their being overlooked. The rocks in which they occur are common in California. Itacolumite, a soft micaceous sandstone, always the associate of the diamond, is also found here. The gravel always found in the river washings so closely resembles the "cascalho," or "diamond gravel" of Brazil, that I think it very probable that if proper search was made diamonds would be found.

Mr. Attwood spent several years in the diamond districts of Brazil, and is familiar with the subject of which he wrote.

In August of this year I visited Cherokee, Butte County, specially to study that celebrated diamond locality. Mr. A. McDermott, druggist of Oroville, says that a diamond was sent to him in 1862 which was as large as a small pea. It was nearly globular and obscuredly crystallized and of yellow color. He does not know the subsequent history of the stone, where it was found, or the owner's name.

At Cherokee, diamonds and zircons are found in cleaning up sluices and undercurrents. The first notice of diamonds at this locality dates from 1853, the largest discovered, which was two and a quarter carats (nine grains), is now in the possession of John More. There have been from fifty to sixty found, from first to last; some were rose colored, some yellow, others pure white, and all associated with zircons, platinum, iridium, magnetite, gold, and other minerals.

A similar association of metals occurs in the northern counties of California, especially in the region drained by the Trinity River, in the sands of which microscopic diamonds are actually found. The same may be said of the vicinity of Coos Bay, in Oregon, and along the banks of Smith River, in Del Norte County. Miners throughout this whole region, and in the hydraulic mines, should search carefully for diamonds, and should send anything they find, which is likely to be such, to the State Mineralogist for identification. Diamonds may be looked for in flumes, and in cleaning up sluices, with gold and platinum. An examination of the platinum sands of the Trinity River was made by Professor F. Woehler, of Gottingen, who found the presence of diamonds in them. After removing gold, platinum, chromic iron, silica, ruthenium, etc., by the usual methods, he examined the residue microscopically, and observed colorless, transparent grains, which he presumed to be diamonds. Subsequent combustion in oxygen and precipitation of solution of baryta, by the carbonic acid evolved, convinced him that the microscopic crystals were true diamonds. This fact is an extremely important one to the inhabitants of the Pacific Coast.

Professor Silliman has made the concentrations from the Cherokee mines, Butte County, a special study, and has published at least two scientific papers on the subject. In his first (Engineering and Mining Journal, February 25, 1873), he gives in detail an account of his chemical and mechanical treatment of the samples furnished to him, all of which is embodied in his second paper, except the examination for microscopic diamonds or diamond dust. His chemical treatment is there described, in which he obtained a reaction for carbonic acid, attributed by him to the oxidation of minute diamonds. The result of my examination, given under the head of "Bedrocks and Gravels," will show that I arrived at the same conclusion after a close examination with the microscope.

In his second paper (American Journal of Science, Vol. 6, 1873), he gives a list of the minerals found in another sample, including platinum, iridium, and gold, that did not occur in the first. The presence of the former minerals suggested a search for "laurite," which was made, but without success. By his finding, these interesting concentrations contain the following minerals, a remarkable association: almandine garnet, chromite, diamond, epidote, gold, iridosmine, limonite, magnetite, platinum, pyrite, quartz, rutile, topaz, and zircon.

The resident manager admitted to Prof. Silliman that the mechanical force of the stream of water used washed away platinum and associated minerals which do not amalgamate with the quicksilver used to arrest the gold, entailing a loss for which there is now no known remedy. I have alluded elsewhere to the imperfect manner of hydraulic mining, and do not hesitate to express the opinion that when these defects are remedied both diamonds and platinum will become important mineral products of the State.

The State Museum is indebted to Mr. Lewis Glass, Secretary of the Spring Valley Hydraulic Gold Company of Cherokee, for fine samples of platinum (No. 4224 gold, No. 4225) and other interesting minerals from that locality.

A fine diamond from the Spring Valley mine, Cherokee, has also been presented to the State Museum (No. 4033) by Mr. G. F. Williams, Superintendent, which has been placed in one of the cases devoted to the display of California minerals. Samples, also, of the gravels, and concentrations of black sands, platinum minerals, lava, bedrocks, etc., have been collected, which are now in process of arrangement, and will soon be displayed in the cases. Samples of the interesting association of black sands described by me, and in Professor Silliman's papers, have been set aside for those who desire to make a special study of them, and to whom specimens will be sent on application. I had the pleasure of seeing a number of other interesting diamonds from this locality during my recent visit. Mrs. Harris has a beautiful Cherokee rough diamond set in a ring. Mr. Harris, who was formerly Superintendent of the Spring Valley Hydraulic mine, has another, which has been cut. Of the two, I consider the natural crystal the most interesting and beautiful. Mrs. W. C. Hendricks, of Morris Ravine, near Oroville, also has a fine Cherokee diamond set in a ring.

Platinum minerals have been found rather abundantly in Butte County. At St. Clair Flat, near Pence, they were found in quantity in the early days of placer mining. It is found also at the Corbier mine, near Magalia (Dogtown). In 1861 a diamond was found one and a half miles northwest of Yankee Hill, Butte County, in cleaning up a placer mine. The stone was taken from the sluice with the gold, and sold to M. H. Wells, to whom I am indebted for this information. Mr. Wells presented the gem to John Bidwell, of Chico, who had it cut in Boston. It weighed one and a half carats—six grains. Mr. Bidwell gave the diamond to his wife, who now wears it on her finger. This was the only diamond found at the locality.

With the information given in this paper, and the specimen in the State Museum, miners and prospectors should be able to recognize diamonds if they find them in their claims, and as it is more than possible that gems of great value may be discovered, it will be well to observe the following rules in dealing with such discoveries: When a stone supposed to be a diamond is found, do not attempt to test its hardness, even by gentle blows with a hammer. To properly test its hardness, a small emery wheel may be used. Any miner can send to San Francisco, or elsewhere, and have such a wheel sent to him by mail. A suitable size would be one about two inches in diameter and one quarter of an inch in thickness. Such wheels are used by dentists and jewelers, and may be obtained from dealers in such goods. The wheel may be laid on the table flat, and the stone rubbed on it. If the stone is worn away in the least degree, it is not a diamond. By this simple test the question may be answered in numerous cases. Should the stone resist the emery wheel, it *may* be a diamond; but this is not certain, for other stones will also stand this test. In this case it would be best to communicate directly with the State Mineralogist, from whom reliable and impartial information may be obtained.

NOTES ON MICA.

Inquiries have been so frequently made at the State Mining Bureau, concerning the uses and value of mica, and so many worthless samples sent for examination, that it has been thought best to publish such facts as will afford the information so often asked.

The uses of mica are few, but as there is nothing to supply its place, and as it is seldom found in large sheets, or in large quantities, it will always command a good price, which will depend upon the supply; and as the demand is steadily increasing, there is no likelihood of the market becoming overstocked. The chances for discovering good merchantable mica in California are better than in most countries, for the reason that the field is new, and that multitudes of educated prospectors are looking for any mineral that can be turned to account. It is to give them all infornation on the subject that this is written, in the hope that a valuable deposit may be found in the State, and to prevent them from wasting their time and incurring unnecessary expense in attempting to develop worthless material.

The writer of the following letter applied to the Mining Bureau for information as to any workable deposits of mica in the State, and gave in return information as to its value in Europe, which he was asked to put in writing for the benefit of those interested:

H. G. Hanks, Esq., State Mineralogist:

DEAR SIR: During a recent journey through Germany I called on Mr. Max Raphael, at Breslau, Prussia, a manufacturer of mica articles, who commissioned me to obtain for him good merchantable mica, of which he is willing to purchase any quantity, and which, he thought, may be found in California and other States of the Pacific Coast.

To enable me to judge of the quality needed by him he gave me some types of such mica as he is using in his factory. It comes mostly from East India, shipped via Calcutta to England. When finally split, the red brownish tint is scarcely visible. Mica from the Pacific Coast has a greenish tint, and is inferior to the East India, yet Mr. R. says it is suitable for his purposes. Herewith I beg leave to hand you some of these types, viz.: Nos. 1, 2, 3, and 4. These are considered to represent merchantable mica. No. 3 is of extra fair quality, though it would scarcely yield plates larger than 3x5 inches, the balance being streaked and worthless. Nos. 5, 6, 7, 8, 9, and 10 are samples of worthless mica. Nos. 11, 12, and 13 are plates such as are obtained from good mica, as shown by Nos. 1 to 4.

The value depends entirely upon the square or oblong sizes which it will yield when split. Sizes less than 2½x5 inches are valueless, for these are abundantly obtained in working up large pieces.

A fair quality of mica, yielding 3x5 inches, is worth about fifty cents per pound; 3½x5, fifty cents; 3x6, sixty-two cents; 4x6, $1; 5x9, $1 25; 7x7, $1 62; 8x8, $1 75; 9x9, $2 25; 10x10, $2 50; 12x12, $3.

These prices demonstrate that the mining of mica can be made very remunerative. Surface mica is always of inferior quality; in going downward the strata become well-defined, less disturbed, denser, and purer. Good mica must be free from flaws and foreign substances, must split readily, and be clear and transparent.

Were such mica obtainable in California or the Pacific States, it would be to the interest of the parties mining to send fair samples to your Bureau. Such samples should not consist of a thin layer split off, or insignificant pieces of the mineral, but be fair specimens of the mine or ledge, taken some five or ten feet below the surface or croppings. These specimens, from one quarter to one and one quarter inches in thickness, need not be trimmed square, but may be pieces in their irregular shape, though freed from adhering rock or ledge matter.

Only when large quantities are to be shipped it is best to trim the pieces oblong in order to save expense.

The party previously named authorized me to contract for the permanent delivery of large quantities. For the convenience of mine owners the mica might be delivered at the mine, or the nearest railway station. Very respectfully and truly yours,

(Signed) HENRY JACOBY.

SAN FRANCISCO, January 30, 1882.

The word mica is used at the present time to designate a group of minerals of different chemical composition, rather than a single species. They were all included under the designation until 1792, when lepidolite was found to be a separate species, and given a specific name, which it still bears. The minerals of the mica group, however, have certain physical properties in common, among which is the characteristic one of cleavage parallel to the basal plane of the crystal. What is generally known as mica, and seen only in very thin laminæ, is in reality only a small portion of the crystal. A perfect crystal of mica is seldom found in nature. This fact results from the facility with which the thin laminæ separate in the plane of natural cleavage. To realize what a mica crystal is like, imagine a multitude of thin cards cut into hexagonal or rhombic forms and piled upon each other, commencing at the base with the smallest, increasing gradually to the center, and diminishing again to the top of the mimic crystal.

Large sheets of mica have been found in Norway and Sweden. In the United States, mica in sheets sufficiently large to have a commercial value has been found at Alstead, Grafton, and Ackworth, New Hampshire; at Mt. Mica, Maine, and in Canada. In 1867, mica mines that had been anciently worked, were rediscovered in Mitchell County, North Carolina. The large sheets of mica brought to the European market are principally from Siberia. The mineral is known in commerce as isinglass (*glaces mariæ*), and sometimes Muscovy glass, because it was first found in quantities in that part of Russia formerly called Muscovy.

Pliny confuses several minerals under the name of "specular stone." Probably mica and selenite are alluded to, in writing of the *lapis specularis*; and it is doubtful which was used "in shavings or scales to sprinkle in the Circus Maximus at the celebration of the games, for the purpose of producing an agreeable whiteness;" but Dana thinks it may have been a silvery mica schist.

Silvery and golden-colored mica were called "cat silver" and "cat gold" in the middle ages.

Richard Kirwan, in his Elements of Mineralogy, published in 1774, thus describes "pure mica:"

This stone in its purest state is colorless, but either from a less intimate combination, or from a mixture of some superfluous ingredient, principally iron, it is found of different colors, white. red, yellow, green, brown, or black. The white and yellow sort have a splendid metallic appearance—smooth, but not greasy to the touch, which distinguishes it from talc. Its texture is always lamellar or scaly, and the lamellæ or scales are slightly flexible and often elastic. These scales are sometimes parallel to each other, sometimes interwoven, sometimes wavy or undulated, and sometimes they represent filaments. Its specific gravity is from 2.535 to 3.000 when loaded with iron. It does not effervesce with acids, and is insoluble in them, without particular management, but after it has been calcined with four times its weight of fixed alkali. it effervesces strongly, and is in a great measure soluble. The pure colorless mica is infusible *per se,* and scarcely melts even with mineral alkali, but yields more readily to borax or microcosmic salt, with scarce any effervescence, but the colored sorts were found by Mr. Saussure to be soluble *per se,* though with difficulty, for they require a stronger heat than shoerl does.

One hundred parts of the colorless kind contain thirty-eight of silex, twenty-eight of argill. twenty of magnesia, and fourteen of the most dephlogisticated calx of iron. Martial mica contains ten per cent. or twelve per cent. of a more phlogisticated calx of iron, from which its various colors are derived, and a proportionately smaller quantity of the other ingredients.

Mica can be distinguished from other minerals by the following tests: It must have the property of splitting into thin laminæ which, by careful manipulation, may be again and again divided into thinner sheets. The scales, no matter how thin they may be, must be tough and elastic, in which they differ from selenite and jefferisite, which are often mistaken for mica. The thin films must be transparent, even if the larger masses were dark-colored and apparently opaque. The surface of the films must be smooth and highly polished, and must remain unchanged when heated to redness in the flame of a spirit lamp or similar source of heat. Mica is easily scratched by a knife, and sometimes with the finger nail. According to Hauy, laminæ of mica may be obtained by division so thin that it would require 250,000 to make an inch in thickness. Mica is never found in very large masses, nor in beds or deposits, yet it is one of the most abundant of all the minerals which form the earth's crust. Slabs of mica have been found in Russia two and one half yards square. In Siberia large masses occur in granite, and are specially mined. Mica is one of the constituents of many of the rocks, as granite, gneiss mica, schist mica, slate, etc. The largest plates occur in veins of granite. It occurs accidentally in syenite, euphotide, hypersthenite, diorite, trachyte, and basalt.

Mica sometimes forms artificially in furnaces in which copper and other metals are melted, and the walls of such furnaces in which sandstones are used for lining sometimes become coated with a fine, pearly mica, which probably derives its potash from the ashes of the wood used for fuel. An analysis of such a formation gave to Mitscherlich the following result:

Silica	47.31
Alumina	5.74
Peroxide of iron	28.91
Peroxide of manganese	10.48
Magnesia	10.17
Potash	1.05
Lime	6.23
	100.89

In crossing certain streams or rivers flowing in shallow sandy beds, quartz sand may be seen to roll forward beneath the water, remaining near the bottom, but particles of mica, frequently of a golden color, rise, with the force of the stream, to the surface, and glitter and gleam in the sunlight like particles of gold, for which they have often been mistaken. This peculiarity of mica was frequently noticed in the Platt River, by the early emigrants to California, and by those who had discovered the mistake it was called "fools' gold."

There is a specimen of yellow mica schist (No. 1626) in the Museum of the State Mining Bureau, from a large deposit, which caused the Gold Lake excitement; and it is so like the precious metal in appearance that it is not surprising the mistake should have been made. With the advancement of invention there has been created an increased demand for mica, which has raised the price to that extent that a deposit of the best quality would be very valuable to the finder.

Mica is made a substitute for glass in certain cases where that material cannot be used, as in front of stoves, bakers' ovens, furnaces, certain lanterns, lamp chimneys, windows in ships of war, as such windows cannot be broken by the concussion of the guns. In chemistry it is sometimes used as a support for substances to be fused, and as thin covers for microscopic objects, where it is desirable to have the cover thinner than can be attained by glass; it is also used in the pans of the balance upon which to place powders and damp or corrosive substances to be weighed. In this case two pieces of equal size and weight are used which counterpoise each other.

Mica is also applied to ornamental purposes. In paper hangings and decorative work it is ground or otherwise separated into a fine scaly powder and sifted over the work in a kind of frosting which is made to adhere by a coating of glue size or paint. Mica of a yellow color is said to be used in the manufacture of artificial aventurine.

Mica is a Latin word, meaning a crumb or grain—little bit—morsel. *Mica salis* is literally a grain of salt, but figuratively a grain of sense. "*Nulla in tam magno est corpore mica salis.*" The name was probably given to the mineral because it was generally found in small grains or flakes in mica schist, or mixed with the sands of streams in minute particles. There seems, however, to be a diversity of opinion, for some writers claim that the name is derived from the Latin *micare* or *mico*, words meaning to shine, glitter, flash, or gleam. The German word *glimmer*, in that language applied to mica, is derived from the same idea. The name mica was given by Hauy, and glimmer by Werner.

Mica forms the scales in aventurine, which is vitreous quartz with spangles of gold-colored mica interspersed through it. There is a vase of aventurine in the Museum of Practical Geology, in London, bequeathed to that institution by Sir R. I. Murchison, to whom it was presented by the Emperor Nicholas I, of Russia. It measures four feet in height and six feet in circumference. It is supported on a pedestal of polished gray porphyry. A similar vase and the only other one in the world was presented to Humboldt, and is now in the Royal Museum at Berlin.

Fine specimens of a variety of aventurine called star stone are brought from Sweden. This stone is white quartz in which small silvery scales of mica are interspersed.

Sedimentary rocks, resulting from the decomposition of the crystalline rocks, and especially granite, contain mica as one of the constituents. There seems to be considerable doubt as to the identity of the mica in mica basalt. Dana thinks that the mineral claimed to be mica is a pseudomorph after olivine, altered by the oxidation of the iron.

The associates of mica are quartz, black tourmaline, indicolite, rubellite, orthoclase and other feldspars, garnet, topaz, hornblende, beryl, lepidolite, cookeite, casitterite, spodumene, amblygonite, dolomite, magnetite, siderite, pyrite, chalcopyrite, andalusite, pinite, and other minerals.

The minerals which are now recognized or classed as micas may be summed up as follows: Astrophyllite, biotite, cryophyllite, lepidolite, lepidolomelane, muscovite, and phlogopite. The following micaceous minerals are principally varieties of the micas, while some authors give to some of them a specific position in their works: Alurgite, adamsite, aspidelite, cookeite, damourite, didrimite, eucamphite, epiphanite, euphyllite, hallite, helvetan, manganophylle, nacrite, odinite, phengite, paragonite, pregratite, pterolite, pihlite, rubellane and sericite.

According to Prof. Silliman, muscovite is the species generally found in the granite rocks, and the phlogopites in serpentine and granular limestone.

Astrophyllite is a rare bronze-yellow or golden-yellow mica, which occurs in long narrow tabular crystals. It is a silicate of iron, maganese, magnesia, lime, soda, potash, and alumina, with titanic acid and zirconium. It is a beautiful mineral, but has no commercial value. Its hardness is 3, and specific gravity 3.324. Before the blowpipe it swells and fuses to a black magnetic globule. With borax, gives a strong reaction for maganese. It is decomposed by boiling hydrochloric acid with separation of silica. Its powder resembles mosaic gold. Named from its stellate crystals.

Biotite—called also hexagonal mica, and iron magnesia mica—is rather a common mineral, which has the following properties: Luster, splendent, more or less pearly; color, green to black, sometimes black, even in thinnest laminæ, blood red or brown by transmitted light. It is a hydrous silicate of alumina, iron, magnesia, and potash, with fluorine and titanic acid, in proportions which vary in different specimens. It is named after Biot, a French naturalist. The chemical properties resemble those of phlogopite, which will be described. Rubellan is an altered biotite.

Cryophyllite is a fusible emerald-green mica—a silicate of alumina, potash, and lithium, with other constituents in small proportions; found only at Cape Ann, Mass., in granite. It has the remarkable properties of fusing in the flame of a candle, and being decomposed by dilute acids.

Lepidolite is a lithium mica, so named by Kirwan, from two Greek words, meaning "scaly stone." Its luster is pearly; color, rose red to violet gray, lilac, yellowish, grayish white, white. This mica, which is not common, is a constituent of certain granites and gneiss. It has no economic value, unless for the extraction of the lithium, of which it contains about five to six per cent. Lepidolite is essentially a silicate of alumina, lithium, and potash, containing also manganese and fluorine. Its hardness is 2.5 to 4.0; gravity, 2.84 to 3.0. In a closed tube it gives water, and reacts for fluorine. Fuses before the blowpipe to a white or grayish glass, which is sometimes magnetic; with hydrochloric acid tinges the blowpipe flame red for a moment only. This beautiful mineral occurs in abundance in San Bernardino County, California, the exact locality not yet being given. It is associated with erythrite (arseniate of cobalt) and rubellite (red tourmaline.) Specimens may be seen in the State Museum.

Lepidomelane.—This is an iron potash mica containing silica, alumina, sesquioxide and protoxide of iron, manganese, magnesia, lime, potash soda, and water in varying proportions. It occurs in small, six-sided tabular crystals, or in an aggregation of small scales. It is unknown in California. This mica is fusible at a high heat to a magnetic black globule. In hydrochloric acid it is decomposed with the separation of silica. Its luster is pearly to adamantine; color, generally black, sometimes green by reflected light; streak, gray green; opaque in mass, but translucent in thinnest scales; laminæ, somewhat brittle. This mica is named from two Greek words, implying black scale. It has no economic value. Annite, bastonite, and pterolite are varieties of this mineral.

Muscovite, called also rhombic mica and biaxial mica, is the common mica of commerce. It was named by Dana, in 1850, from "Muscovy glass," the common name, as before mentioned. It is one of the constituents of the granites, gneis, mica schist, and some of the sedimentary rocks. It is a potash mica, which plays an important part in the natural formation of soils, and is, probably, the source of the potash in plants and in the potash minerals of the secondary formations. The constituents of muscovite are silica, alumina, protoxide, and sesquioxide of iron, lime, soda, potash, water, and fluorine; but the proportions are so different in different localities, that no single analysis would have any value if given here. The colors also vary as much as the composition. The following variety of colors are known: White, silvery white and grayish white, rose, clear pale rose and gray rose, black and greenish black, green, emerald green (fuchsite), faint green, brownish green, pale green, clear olive green, olive green and blackish green, brown with patches, dark brown, light brown, violet brown, smoky brown, pinchbeck brown and whitish brown, gray, violet gray and greenish gray, yellow and greenish yellow, white, brownish white and greenish white, blonde, grayish blonde and yellowish blonde, colorless, pearly, and giving a silvery reflection.

The hardness of muscovite is 2 to 2.5, specific gravity, 2.75 to 3.1. Before the blowpipe, it whitens and fuses on the thinnest edges to a gray or yellow glass. With the fluxes, it gives a reaction for iron, and sometimes for manganese and chromium. In a closed glass tube it gives a little water, and with Brazilwood paper the reaction for fluorine. The laminæ are very flexible, tough, and elastic.

Fuchsite, named from the chemist Fuchs, is a chromium muscovite, sometimes containing as much as four per cent of the oxide of chromium. Margarodite is a hydrous potash mica altered from muscovite by hydration, which it resembles both in crystallization and appearance.

The largest sheets of Pacific Coast muscovite which have come to the notice of the State Mining Bureau are those in the Museum, numbered 2160, and presented by the late Joseph Mosheimer; they are from New Mexico.

Phlogopite, or rhombic mica, sometimes also called magnesia mica, is a silicate of magnesia, alumina, and potash, with small proportions of other constituents. A sample from Gouverneur, New York, gave to Rammelsberg the following analysis:

Silica	41.96
Alumini	13.47
Protoxide of iron	2.12
Oxide of manganese	.55
Magnesia	27.12
Lime	.34
Soda	trace.
Potash	9.37
Water	.60
Fluorine	2.93
Total	98.46

Phlogopite is characteristic of the serpentines and limestones. It is sometimes found in crystals of great size; one, in the cabinet of W. W. Jefferis, is twenty inches long, four inches thick at the top by eight and one half inches in the center. This remarkable crystal weighs fifty-seven and one half pounds.

The color of phlogopite is yellowish brown, sometimes copper colored. In thin sheets it is translucent or transparent. The laminæ are tough and elastic. No. 1404, in the State Museum, is a fine specimen of the copper colored variety found in Burgess, Canada. The hardness of phlogopite is 2.5 to 3.0; gravity, 2.78 to 2.85. In closed tube it gives water; before the blowpipe, turns white and fuses on the thinnest edges. It is decomposed by boiling hydrochloric acid, silica separating. This mica is seldom found in sheets large enough to be useful in the arts and it has therefore no economic value. It is named from a Greek word meaning fire-like.

The following is a list of mica minerals in the State Museum. The figures are the catalogue numbers:

159. Mica Muscovite—El Dorado County, Cal.
460. Garnets in Mica Schist—Sitka, Alaska.
608. Lepodolite—Middletown, Conn.
617. Muscovite—Middletown, Conn.
798. Mica Schist—Gold Lake, Plumas County, Cal.
1092. Mica Schist—Ivawatt district, San Bernadino County, Cal.
1404. Copper Mica, Phlogopite—Burgess, Canada.
1408. Mica—Canada.
1626. Mica Schist—Found at the ruins of Casa Grande, Pinal County, Arizona, lying on the ground in considerable quantities. Probably used in the manufacture of pottery.
1821. Mica Schist—Philadelphia, Penn.
2031. Mica Crystal—Paris, Maine.
2126. Jeffersite—Susanville, Lassen County, Cal.
2160. Muscovite—New Mexico.
2481. Muscovite—Near Tucson, Pima County, Arizona.
2953. Muscovite—Pennsbury, Penn.
2966. Plumose Mica Muscovite—Salsbury, N. H.
2980. Phlogopite—St. Lawrence County, N. Y.
3061. Phlogopite—Burgess, Canada.
3073. Phlogopite—Templeton, Ottawa County, Canada.

To ascertain the price of mica in San Francisco, two samples were bought at a retail stove store; one was five by six inches, and the other two and one half by five inches, and the thickness being measured with a Jackson micrometer, it was found that it would require a pile of 133 such sheets to make an inch. They were weighed and the smaller required 119 sheets to the pound and the larger 68 sheets. The price paid for them was at the rate of $11 86 for the smaller and $13 70 for the larger. By this it will be seen how high a price the consumer is compelled to pay for the mineral in small quantities. Mr. Jacoby in his letter has given the price that the European manufacturers are willing to pay for it.

NOTES ON ROSCOELITE.

Roscoelite is a new and extremely rare mineral found in El Dorado County, California. Attention was first called to it by the reading of a paper by Dr. James Blake, at a meeting of the San Francisco Microscopic Society, July 2d, 1874. The specimens then exhibited were from a mine or claim known as the "Stuckslager," "Plum Tree," or "Sam Simms" mine, which lies in section 24, township 11 north, and range 9 east, Mount Diablo base and meridian, somewhat more than a mile from the Town of Coloma, in a southwest direction.

At a meeting of the California Academy of Sciences, held July 20th, 1874, Dr. Blake presented specimens of the same mineral, which he then supposed to be a chromium mica, having in a preliminary examination found, as he supposed, chromic acid combined with silica, potash, and lithium. Gold was also associated with the mineral in considerable quantities. He stated that it was found at Granite Creek, near Coloma, El Dorado County, remarking at the same time that the associated minerals were an interesting and beautiful microscopic study, and that the formation indicated that the gold must have been deposited between the flakes of the mica from an aqueous solution. He gave the new mineral the provisional name of "colomite," from the locality.

The next notice appears in the proceedings of the California Academy of Sciences, volume 6, 1875, folio 150. At a meeting held August 2d of that year, Dr. Blake read a paper on "roscoelite," a new mineral, in which he admitted that he had stated at a former meeting that the mineral contained a large quantity of chromic acid, an opinion derived from the results of superficial blowpipe tests. He had since sent samples to Dr. Genth, of Philadelphia, who found it to contain vanadium. He had given the name roscoelite as a compliment to Professor Roscoe, of Manchester, England, who has made vanadium a special study. In a foot-note Dr. Blake expresses the opinion that vanadium may occur in these rocks in larger quantities than is generally supposed, and calls attention to the fact that Dr. Hall has found it widely diffused in many rocks.

The vein from which the roscoelite was taken is small and not continuous, varying from two inches to a foot in thickness, running nearly parallel with Granite Creek. The quartz is ferruginous in appearance, and is associated with calcite and slaty matter, and at least two varieties of pyrites. Gold only occurs with the roscoelite, and usually in parts of the vein where the quartz disappears or "pinches out," as the miners express it.

Roscoelite was for a long time a mystery to the miners, and was first mistaken for plumbago. The pioneer placer miners at Big Red Ravine used to complain of the difficulty of saving the gold, owing to the interference of the "black stuff," as they designated it. In all probability a large quantity of gold was allowed to escape, from ignorance of the nature of this mineral. Gold is found interstratified with laminæ of roscoelite, or imbedded in it, in pieces from the value of one dollar to the minutest microscopic particles. The method of operation at the mine has been to remove the superficial slaty covering by ground sluicing, and carefully working the small but exceedingly rich material found in the pay seam. From one pan of this, forty ounces of gold have been taken; from another, gold to the value of $100 was obtained. The fineness of the gold is 846.

Under the microscope roscoelite is seen to be in scales and radiated tufts, the luster of which is silvery, or pearly, to a high degree—almost metallic by strong reflected light; color, light steel gray, yellowish dark green, or nearly black, as seen in different lights. Small, deeply striated crystals of white iron pyrites are sometimes seen on freshly broken surfaces of quartz, partly imbedded. The quartz in actual contact with roscoelite is generally transparent and nearly colorless; sometimes rose colored or amethystine. Although rather common in the ores, pyrites has not been observed in contact with roscoelite.

When magnified seventy diameters, roscoelite resembles the variety of pyrophylite found at Greaser Gulch, Mariposa County. As far as observed, the associated gold is always bright, of good color, and amorphous, generally rounded as if water worn.

The other mineral associates of roscoelite are calcite, and a yellow mineral, which is probably marcasite or chalcopyrite, found only in microscopic quantities.

The only other known locality of roscoelite in the State, is section thirty-one, township eleven north, and range ten east, two miles from the Sam Simms mine. Big Red Ravine is on this section, lying only two miles from the site of Sutter's mill, where gold was first discovered. It was one of the earliest placer mines known in the State, and so rich did it prove, that it has paid to rework as many as seven times. It is in the bedrock of these old workings that roscoelite is found.

I am indebted to Mr. George W. Kimble, Surveyor of El Dorado County, for valuable information, and for specimens of this rare and interesting mineral. With him I walked over the ground, while he pointed out the localities. The largest mass found here was taken out by a Chinaman, and is described as having been as large as a gallon measure. From first to last 400 to 500 pounds of roscoelite have been obtained, all of which was wasted in extracting the gold. I was only able to obtain for the State Museum a thin piece of quartz of a few inches superficial surface, coated on both sides with roscoelite—some large masses showing the mineral in spots—and some beautiful microscopical specimens containing gold.

At the Red Ravine locality, roscoelite is found in a dark colored, bluish, micaceous rock, in small seams of quartz and calcite with gold. This rock has not yet been studied.

Through the politeness of Mr. James Taylor, of Owen's College, Manchester, England, I have been furnished with the following analyses of roscoelite:

Analysis of roscoelite by Prof. H. E. Roscoe, of Owen's College, Manchester, England:

Silica	41.25
Vanadic acid (V, 2; O, 5)	28.60
Alumina	12.84
Sesquioxide of iron	1.13
Oxide of manganese (Mn., 3; O, 4)	1.10
Lime	.61
Magnesia	2.01
Potash	8.56
Soda	.82
Water combined	1.08
Moisture	2.27
Total	100.27

Analysis of roscoelite by F. A. Genth, of the Laboratory of the University of Pennsylvania:

Silica	47.69
Oxide of vanadium (V, 6; O, 11)	22.03
Alumina	14.10
Protoxide of iron	1.67
Magnesia	2.00
Potash	7.59
Soda	.13
Insoluble silica, quartz and gold	.85
Loss on ignition	4.96
Lime and lithium	traces.
Total	101.02

ON THE OCCURRENCE OF VIVIANITE IN LOS ANGELES COUNTY.

Among a set of samples from Brea Ranch, Los Angeles County, sent recently to the State Mining Bureau by Mr. J. W. Redway, of Los Angeles, was one of dark color and earthy texture, containing small nodular masses of a beautiful pale blue color, which were examined and found to be vivianite, or hydrous phosphate of iron. This mineral, which is rare in California, is interesting as leading to the hope that other phosphates, so important as fertilizers, may be found at or near the new locality. There is a specimen of vivianite in the Museum of the State University, which is said to be from a California locality; but if my memory serves me, this is attended with some doubt. It is reported, also, at Young's Hill, Yuba County, and near Oroville, Butte County, but no certain information has been obtained.

The Los Angeles mineral occurs with asphaltum at the well-known Brea Ranch deposit. The specimen is marked, "Gangue and Country Rock."

The mass is a dark colored earthy mineral, with streaks and veins of asphaltic substance, the whole being evidently the sandy desert soil, blown over and cemented by liquid asphaltum. The vivianite is in small inclosed nodules, never larger than a pea, and generally smaller. The mineral is that variety known as blue iron earth or native Prussian blue. It is soft, pulverulent; under the microscope, crypto-crystalline; before the blowpipe, whitens for an instant, then blackens and fuses to a black magnetic globule. It is wholly and easily decomposed by boiling hydrochloric acid; the solution reacts for iron, which, being separated, the solution gives precipitates with sulphate of magnesia and with molybdate of ammonia. In a closed tube, it gives much water.

The specimen has been numbered 3538, and placed in the State Museum, where it may be seen.

The name vivianite was given to this mineral by Werner, after an English mineralogist, J. G. Vivian, who discovered it in Cornwall. When pure it has the following composition, as given by Dana: phosphoric acid, 28.3; protoxide of iron, 43.0; water, 28.7.

DIATOMS AND DIATOMACEOUS EARTHS.

A diatom is generally admitted to be a single-celled plant, bearing a singular relation to the animal and even to the mineral kingdom, being considered by some as belonging partly to the latter, and regarded as a vegetable crystal, differing only from minerals in having the power of locomotion and of multiplying by separation. Kutzing says: "In comparing the arguments which indicate the vegetable nature of the diatomaceæ with those which favor their animal nature, we are, of necessity, led to the latter opinion."

In connection with the idea that the diatom pertain somewhat to the mineral as well as the animal kingdom, it is a curious fact that silica, deposited from fluoride of silicon, if crushed between plates of glass, and examined microscopically, with a medium power, markings may be seen on the outer surfaces of the vesicles which resemble those of the diatoms, specially pleurosigma and coscinodiscus. It is also remarkable that Dr. James Blake collected fifty species of living diatoms from a hot spring in Pueblo Valley, Nevada, the temperature of which was 163 F. Flint probably originates from diatoms, as does also the silica in certain rocks.

The name diatom is derived from a Greek word signifying being cut in two. Diatoms resemble the desmids, but differ in having an outer skeleton, or frustrule of silica. The frustrule of a diatom is a silicious box, always in two parts, one slipping over the other like a pill box, or with edges opposed. The thickness of a single diatom is, roughly, the sixth that of a human hair, and its weight is estimated at the 187-millionth part of a grain. Some varieties attach themselves to other bodies as the algæ, while others swim in the water free.

The study of the diatomaceæ, aside from the scientific interest, is very fascinating. Their extreme and varied beauty is a source of constant pleasure to the microscopist, and the question is often asked, why is so much beauty vailed from human sight?

The beauty of the diatoms consists in their color, their general form and sculpture, or natural markings, which characterize nearly all of them. These delicate markings are seen under the microscope to be processes, knobs, bosses, concavities, ribs, groovings, and lines, so minute that the highest powers made by the most skillful opticians are required to see them at all; even then, they can only be seen when the apparatus is manipulated by the most skillful operators. The lines of certain diatoms have been measured and are used to test the magnifying and penetrating power of object glasses. A slide called a test plate has been prepared, on which twenty well known species are mounted, commencing with one on which the lines are comparatively coarse, and ending with one—*Amphipleura pellucida*—which has 130,000 lines to the linear inch. For the convenience of study, typical diatoms are mounted on a single glass slide, so arranged that reference can be made to a printed catalogue for the names, while in some cases the names of the species are micro-photographed on the slide.

The diatoms are placed on the plate by the aid of an ingenious device called a mechanical finger, by means of which the shells can be picked up singly and given the desired position. Moller's typen platte number one has four groups, twenty-four lines in each, comprising about 500 individuals, of 395 distinct species and seventeen genera. The cost, with printed catalogue, is forty dollars. Some microscopists are so fond of the study of these minute forms, that they scarcely do any other work than to observe. collect, classify, and describe them.

When it is stated that the names of more than 4,000 distinct species of diatoms are given in a catalogue published by Frederick Habirshaw, of New York, each of which has some feature by which it may be distinguished; that this vast kingdom, so to speak, is invisible to the human eye, or nearly so; that when highly magnified many of the species are extremely beautiful, and all of them interesting, it is easy to understand why so much interest is taken in them the wide world over, and why every new discovery is heralded, and calls for samples come from the whole scientific world.

It is an established fact, strange as it may seem, that some of the greatest mountain chains, such as the Andes, and the very soil beneath our feet, is chiefly composed of the remains of animalcules, invisible to the eye; that is to say, the matter has been used by animated beings and returned again to the mineral kingdom, retaining the form which it assumed while a part of their minute bodies. Byron has written, with more truth than he probably realized, that "the dust we tread upon was once alive;" and the remark of Dr. Buckland is often quoted: "The remains of these minute animals have added more to the mass of minerals which compose the exterior crust of the globe than the bones of the elephants, hippopotami, and whales."

In the tertiary age, beds of diatomaceous or infusorial earth were deposited, consisting almost wholly of these microscopic organisms. The extent of some of these deposits is almost incredible, and is regarded as an evidence of the great age of the world. The Bohemian deposit in Europe is fourteen feet thick, and, by the estimation of Ehrenberg, contains 40,000,000,000 diatoms to the cubic inch.

Darwin observed in Patagonia, along the coast, for hundreds of miles in extent, a bed of tertiary sedimentary formation 800 feet in thickness, overlaid by a stratum of diatomaceous earth. At Bilin, in Austria, a bed of infusorial earth, fourteen feet thick, occurs. One merchant sells annually many hundred tons of it. The *Bergh mehl*, or mountain meal of Lapland and Norway, is from beds thirty feet in thickness. It must be remembered that these deposits extend over many thousands of square miles. Notwithstanding the astonishing fact that vast areas of the earth's surface are built of these minute forms, the true nature of these deposits was not known until 1837, when Ehrenberg published his celebrated work on that subject. The same deposition is taking place at the present time. In certain lakes in the United States and elsewhere, deposits several inches in thickness accumulate, composed wholly of the remains of recent diatoms. When thoroughly dried, a chalky powder is obtained, which, under the microscope, is easily recognized. Similar deposits have been made known by dredging the bottom of the sea.

According to Prof. Joseph Le Conte, of the California State University, in the deeper parts of Lake Tahoe, which sediments do not reach, the ooze is composed wholly of diatoms or infusorial shells.

Dusty showers of a grayish or red color, are not unfrequent on the Atlantic and Indian Oceans, near the coast of Africa. Ehrenberg examined this dust, and found it to consist largely of diatoms. He estimated the quantity let fall during a dust shower in the year 1846, near Lyons, at 720,000 pounds, one eighth of which was diatomaceous, or 90,000 pounds, equal to forty-five tons. Diatomaceous earth may be distinguished from other formations of a similar appearance by its insolubility in acids, extreme lightness, power of absorbing liquids, and property of polishing metals. It is instantly recognized under the microscope in the hands of one who is familiar with its use. Diatomaceous earth has its uses as well as its scientific interest. It is largely consumed as a polishing powder, under the name of tripoli, from the locality which first gave it to commerce. It is known in California by the absurd name of *electro-silicon*, and at the East by a variety of trade names. It is a very convenient source of soluble silica, employed in the manufacture of silicate of soda or potash, also known as soluble glass. The manufacture of this compound is simplicity itself. Carbonate of soda, or potash, as the case may be, is dissolved in boiling water to saturation, in a capacious iron kettle, and fresh hydrate of lime added until all the carbonic acid is precipitated, and the alkali becomes caustic. Diatomaceous earth in a powdered state is then added as long as silica is dissolved, and the whole covered and allowed to cool. When the insoluble matters have settled, the clear liquid is drawn off and evaporated in a clean vessel to the required density.

Diatomaceous earth is also used in the manufacture of porcelain, and it is a constituent of certain cements and artificial stones. At one time it was claimed to be a fertilizer, but this is thought to be a fallacy, although Ehrenberg states that the fertilizing power of the Nile mud is furnished by fossil infusoria. Slabs of diatomaceous earth absorb liquids with avidity, and are used in laboratories for drying crystals and filters. This property might be more generally utilized if better known.

A convenient contrivance for lighting fires is a lump of diatomaceous earth with a handle of stout iron wire. It is dipped into a vessel of petroleum, placed in the stove or fireplace, and lighted with a match. It continues to burn safely for some time. It can be used again and again. No person, however, should make use of it who has not the common sense to carefully set away the vessel containing the coal oil before lighting the match.

Bricks that float in water are made of diatomaceous earth mixed with one twentieth part of clay and well burned. The art of making these floating bricks was well known in the time of Pliny, but was afterwards lost. It has recently been rediscovered. In the Italian department of the Paris Exposition of 1878, these bricks were exhibited, which attracted considerable attention. Floating bricks, made wholly of California material, may be seen in the State Museum.

Keiselghur, or "flint froth," of the Germans, from a deposit in Hanover, is extensively used in the manufacture of dynamite, giant powder, lithofracteur, and other explosives. Diatomaceous earth absorbs from three to four times its weight of nitro-glycerine, with the advantage over other absorbants of retaining the nitro-glycerine under greater pressure. Dynamite contains 27 per cent. and lithofracteur 23 per cent. of diatomaceous earth. Before the keiselghur can be used, it is subjected to treatment to remove water, all organic matter, and coarse particles. It is first calcined in a succession of furnaces, crushed between rollers, and sifted. It is claimed that the diatomaceous earths of California are unfit for this purpose, but it is my opinion that they have not had a fair trial.

Diatomaceous earth is largely used in the manufacture of soap, to mechanically increase its detersive power. The Standard Company receive large quantities of it from the southern counties of the State. A polishing powder is sold in San Francisco under the name of "El Dorado Polish." It comes from Prospect Flat, three fourths of a mile from Smith's Flat, near Placerville. It is a diatomaceous earth. The deposit is called the "Silicon lead."

Diatomaceous earth has been used with cement, as a lining for fire-proof safes, and in the fining of wines. It is not to be supposed that all the uses of this remarkable substance have been discovered; it remains for the intelligent inventor to search for new applications.

Diatomaceous earths are abundant in California, some of them being very interesting. The Monterey deposit has long been known to the scientific world. Dr. James Blake, who has made this subject a special study, thinks that all the California earths are of the miocene age.

The following is a list of the localities represented in the State Museum, samples of which (except the Santa Monica) will be furnished to specialists who make application for them. The numbers refer to the Museum catalogue:

35. Santa Monica, Los Angeles County.
175. Ione Valley, Amador County.
240. Los Angeles County.
436. San Gregorio, San Mateo County.
444. San Joaquin Valley, near San Carlos Ranch.
547. Seacoast, 40 miles north of San Diego.
557. Staples' Ranch, San Joaquin County.
654. Ten miles north of Petaluma, Sonoma County.
791. Santa Barbàra.
830. Monterey County.
1184. Near Comanche, Calaveras County.
1246. Lost Spring Ranch, Lake County.
1284. Santa Catalina Island.
1331. Dutch Flat, Placer County.
1448. Port Hartford, San Luis Obispo County.
1742. Fourteen miles below San Pedro, Los Angeles County.
1832. Eighteen miles southeast of Santa Rosa, Sonoma County.

Of all those mentioned above, the Santa Monica is the most noted. Slides of this material grace the cabinets of microscopists in all parts of the world, and yet the deposit from which it came is not known. The history of the specimen which furnished so much to science is interesting.

In March, 1876, Mr. Thomas B. Woodward, then connected with the United States Coast Survey, sent a fragment of diatomaceous earth to the California State Geological Society, which he found in tidal refuse on the seashore near Santa Monica, Los Angeles County. The piece could not have weighed more than two pounds, and had so long been subjected to the action of the waves that the edges and angles were rounded. The exact locality was two miles southeast of the lagoon, and several mines southeast of Santa Monica. He saw no other sign of a deposit of the earth. The genuine Santa

Monica (which name refers to the waif) is now the most interesting of any known, and is prized above gold. Several attempts have been made to discover the origin of the fragment, but so far without success.

The following list of diatoms found in the Santa Monica will give some idea of its prolific character. The list is by no means complete, being only those identified by William J. Gray, M. D., of London, England; Charles Stoddar, of Boston, Mass.; F. H. Engels, M. D., of Nevada City, Cal., and Wm. Norris, of this city. The State Mineralogist will be pleased to receive contributions to the catalogue from any diatomist who may see this article:

DIATOMS FOUND IN THE SANTA MONICA EARTH.

1. Actinophæni splendens.
2. Actinoptychus superbus.
3. Actinocyclus interpunctatus.
4. Arachnoidiscus ornatus.
5. Arachnoidiscus ehrenbergii.
6. Amphitetras elegans.
7. Amphitetras wilkesii.
8. Asterolampra variabilis.
9. Asteromphalus darwinii.
10. Auliscus elegans.
11. Auliscus mirabilis.
12. Auliscus notatus.
13. Auliscus pruinosus.
14. Auliscus racemosus.
15. Auliscus reticulatus.
16. Auliscus sculptus.
17. Auliscus hardmanianus.
18. Aulacodiscus browneii.
19. Aulacodiscus kittonii.
20. Aulacodiscus margaritaceus.
21. Aulacodiscus oregonensis.
22. Aulacodiscus pulcher.
23. Biddulphia aurita.
24. Biddulphia johnsoniana.
25. Biddulphia tuomeyii.
26. Campylodiscus.
27. Chætoceros.
28. Climacosphenia moniligera.
29. Cocconeis parmula.
30. Cocconeis punctatissima.
31. Cocconeis fimbriata.
32. Cocconeis scutellum.
33. Cocconeis splendida.
34. Cocconeis pseudomarginata.
35. Cocconeis grevillii.
36. Coscinodiscus gigas.
37. Coscinodiscus concavus.
38. Coscinodiscus oculus-iridis.
39. Coscinodiscus subtilis.
40. Coscinodiscus robustus.
41. Cosmoidiscus elegans.
42. Cresswellia rudis.
43. Dictyocha(?) variens.
44. Ditylum.
45. Discoid forms—rare and very plenty.
46. Euodia gibba.
47. Eupodiscus oculatus.
48. Eupodiscus rogersii.
49. Endyctia oceanica.
50. Gephyria constricta.
51. Gephyria gigantea.
52. Gephyria incurvata.
53. Gephyria telfairiæ.
54. Grammatophora marina.
55. Grammatophora—unnamed large variety.
56. Grammatophora macilenta.
57. Grammatophora serpentina.
58. Goniothecum.
59. Glypodiscus stellatus—4, 5, and 9 processes.
60. Hyalodiscus californicus.
61. Hemiaulus californicus.
62. Hercotheca.
63. Heliopelta leeuwenhoekii.
64. Heliopelta nitida.
65. Isthmia nervosa.
66. Melosira sol.
67. Navicula californica.
68. Navicula excavata.
69. Navicula lyra.
70. Navicula nebulosa.
71. Navicula prætexta.
72. Navicula spectabilis.
73. Omphalopelta moronensis.
74. Omphalopelta versicolor.
75. Plagiogramma.
76. Pleurosigma.
77. Podosphenia.
78. Porpeia quadrata.
79. Porpeia ornata.
80. Rhabdonema adriaticum.
81. Raphoneis.
82. Rutilaria epsilon.
83. Rutilaria obesa.
84. Stictodiscus californicus.
85. Stictodiscus hardmanianus.
86. Stictodiscus—new form.
87. Synedra—very large.
88. Stephanopyxis oblongus.
89. Stephanopyxis umbonatus.
90. Surirella.
91. Stauroneis aspera.
92. Triceratium arcticum.
93. Triceratium montereyii.
94. Triceratium parallelum.
95. Triceratium wilkesii.
96. Triceratium—large variety of forms.
97. Triceratium, with five or six angles.
98. Xanthiopyxis—new.
99. Xanthiopyxis oblonga.
100. Xanthiopyxis umbonatus.

CONTRIBUTION TO THE ETHNOLOGY AND GEOLOGY OF THE PACIFIC SLOPE.

[By Philip Harvey, M. D., of Portland, Oregon.]

Ethnology has followed geology in shaking off the trammels of a narrow chronology, and now man, as well as the world he inhabits, is generally admitted to be of vastly greater antiquity than was supposed to be the case even a few years since; besides, errors in regard to time, others arising from hasty generalization, false reasoning in regard to facts, and still worse, from giving too loose a rein to fancy, have infused so much fallacy into the current ethnology of our native tribes that it has become, in many respects, but little better than a myth. Among these are whimsical notions about America being really the old world instead of the new one, and of man and the higher mammals having originated here and gradually spread to other parts of the world; about the "Mound Builders" as a distinct race from the other Indians; about the "Lost Tribes" of Israel and their having wandered off to this continent, and other transatlantic migrations by which America is fancied to have acquired inhabitants and civilization, and of California having been the Ophir of Solomon. All these views I look upon as being entirely baseless, though some of them are maintained by scientific and even eminent writers. Their fallacy in many respects has been exposed, but they are reiterated, and in fact some of them have taken so firm a root in the public mind that it will require persevering effort to weed them out. Part of my paper will be directed to this end, while part may be found to treat on more original topics.

Geology and the study of the extinct and living fauna of a region, combined, supply us with the means of locating, approximately, the part of the world in which man must have originated. Geology teaches us that the different strata of the earth's crust are arranged in a chronological series, succeeding each other as States and empires have done. Where no great disturbances have taken place, the uppermost strata are the newest, and the lowest are the oldest. As we descend the forms of life are observed to change, differing more and more as we go down by limited and sometimes almost imperceptible gradations. The more ancient the fossil, the more is it found to differ, as a general rule, from the fauna and flora of to-day. At the same time, we notice that, usually, the more specialized or differentiated forms are the newer, and the less so the older ones; in other words, the newer and more advanced types possess a more perfect definition of different organs for the performance of different functions. But these types have not changed everywhere with the same rapidity. They have changed most quickly in the old world, less so in North America, still less in South America, and least of all in Australia, where present leading types of life are, in form and pattern, the most ancient anywhere now extant and living; that is to say, on any extensive area. In this assertion, that Australian leading forms of life are the most ancient, it might, perhaps, be objected that on the Gallapago Islands, according to Chas. Darwin, no higher forms than reptilian, save birds that may have wandered there, were originally found; but, from such a narrow sphere no generalization can be drawn. Still, however slight its importance, the fact serves to confirm the idea that organic progress is retarded to some extent in proportion to the smallness of the territory to which it is limited. The axiom may be stated thus: The smaller and more detached the tract of country, the more slowly it has changed its forms of life. Australian fauna of the highest types yet retain the characteristics that prevailed in other parts of the world when marsupial forms were there the most advanced. In the old world we find marsupials only among the fossils of tertiary times, and in the new world they have disappeared also, except a few small species.

In Australia there were—when it was first discovered—no apes, no carnivora, no ungulata, and no edentata. Of its 132 mammalian species, 102 are marsupials, and the remnant consists of rodents, bats, and strange monotremata. To these man was an intruder, and brought with him a carnivorous animal, the dingo or Australian dog. South America has also a fauna of its own, the most marked and characteristic of which are the edentata. All of its species, a majority of its genera, and even of its more comprehensive groups, are different from those of the old world. The original mammalia of South America and Australia—that is, of the time of their discovery—are more allied to the forms of tertiary times than in ours, and in both these regions animal forms have been changed more slowly than they have in North America or the old world. Before the upheaval of the Isthmus of Panama, an event of recent times, geologically speaking, South America was an island. According to the views of the evolutionists that are now generally accepted by scientists, these two districts retaining their ancient inhabitants, are neither of them a zoölogical province in which the most modern of all forms, man, can have originated. North America has in its flora and fauna much that is similar to and some things that are identical with those of Asia and Europe; nevertheless, it has remained in some of its forms of life more ancient, especially in its two marsupials, *Didelphis virginica*, and *D. californica*.

The fact of the gradual succession of the forms of organic life is no longer a disputed point; but they need not have originated where found; they may have migrated from a distance, but in the absence of disturbances in the order of succession by migration, we have a right to expect that each form of life should everywhere have been preceded by the one next in rank below it. Anthropomorphous apes, or their vestiges, have not been found in America. They could not have crossed from Asia by way of Behring's Isthmus, from the inability of that family to endure so cold a climate, supposing, as we have every reason to do, anything like the present temperature of those regions extended as far back as the tertiary times in which the apes originated. To be sure, the temperature of high latitudes may have undergone great vicissitudes in the ice times, and the intercurrent mild periods recognized as interglacial, a point that I will again refer to; but this could not have enabled those animals that were fitted to dwell only among the tropics to have endured even the brief, though cold Winters that must have occurred in the warmest interglacial time in those high latitudes. These things forbid our looking upon any portion of the American continents as the primal home of man, which should rather be sought for in the native haunts of the orang, the gorilla, or the chimpanzee, or regions accessible therefrom. Since we are precluded from considering America as the cradle of the human race, to arrive there, man must have crossed either ocean, unless the old and new worlds were formerly connected, as indeed they most likely were.

When man first put his foot on the western continent, I should say, rather, the American, he undoubtedly occupied a low position on the scale of moral development. He may have had a language, the bow and arrow, and the art of making fire, though but little beyond; but neither language nor inventions afford the best criteria for determining the origin of a race; these are to be looked for in structural affinities—that is to say, in personal traits. A strong proof that the aborigines of America came from the other side of Behring's Strait, is to be found in their decidedly Mongolian features. The Asiatic and American tribes, on either side of it, are so much alike that you may still mistake one for the other, though probably hundreds of thousand of years have elapsed since their separation. To this close resemblance, that obtains from Alaska to Patagonia, and through all the intermediate regions, all observers unite in bearing testimony. Oscar Peschel, of Leipsic, in his Volkerhunde, or "Races of Man," a recent work, than which none ranks higher as an authority, and to which I take this opportunity of acknowledging a large indebtedness, remarks: "In the writings of those who consider the American Indians a distinct race, we look in vain for characteristics that would serve to distinguish them from Asiatic Mongols. The coarse, long hair, cylindrical in its transverse cut, is found in all Indian and Mongol tribes. The growth of beard is always scanty, sometimes entirely wanting, and the hair on the body is sometimes wanting, too." These last traits, though common to both, are more marked in the Indians. In cranial measurement, also, our Indians closely approach the Mongolian tribes. In short, there can be no certain distinction drawn, and the "Red Man of America" is now very generally looked upon as a Mongolian offshoot.

We may suppose that not only man, but many of the large mammals, that have since become quite extinct on this side, passed over into America from Asia by way of Behring's Isthmus, that we must suppose to have occupied the present place of the strait so called, not only once, but at many periods in the world's history. I here refer to the elephant family, that multiplied on this continent down to comparatively recent times, as well as to the horse, camel, rhinoceros, and hippopotamus, species of which still endure in the old world, though they have become extinct in this. It is all but certain that these animals came from the Asiatic side, and that they came by land.

I refrain from alluding to a host of linguistic analogies, manners, customs, superstitions, tales, myths, and arts that are common among Mongolian and Indian tribes, and that go to show an ancient connection, as it would only be multiplying proof unnecessarily, and extend my article to an undue length, and, as I have said, all these things are, as race characteristics, subordinate to personal conformation.

The migrations of man and animals from the Asiatic side of our neighboring sea may have taken place at various times during the pliocene and post-pliocene eras; the last one was probably during a mild interglacial period of the last glacial epoch, when the accumulation of circumpolar ice had been transferred from the northern to the southern hemisphere by the precession of the equinoxes during a maximum of eccentricity of the earth's orbit, according to Croll's theory, as explained in his work on "Climate and Time," to which I must refer the reader, my limits not allowing me to go fully into the subject here. The shifting of large accumulations of ice from the high latitudes of one hemisphere to those of the other, would necessarily take with it, by the force of gravitation, an amount of oceanic water, and in this way flood one region to some extent, and leave the other correspondingly deficient in water. Thus, the shallow sea of Behring's Strait must have been converted into an isthmus in the interglacial times, and afforded land transit from one continent to the other.

The first crossing of man may have taken place subsequently to these animal migrations, and when the sea had resumed dominion over the shallows of the North, and given to Behring's Strait its present form. An objection to this supposition exists in this, that he was not then sufficiently skilled to make sea-going vessels of any kind, under which circumstances he must have come by land. According to the astronomical calculations of Leverrier and Croll, the last eccentricity of the earth's orbit sufficient to have caused great glacial and interglacial times occurred somewhere near 200,000 years ago. Of these times there are supposed to have been several during the epoch of eccentricity, the two together covering a period of 20,000 years. It is most likely, then, that the advent of man to this continent occurred about 200,000 years since, during one of those mild and balmy interglacial periods, when the climate of the north part of our temperate zone was at its best, when the continents were united, and a sea of verdure, instead of water, extended from Kamtchatka to Alaska, covering both these regions also. Alaska was then well fitted for colonization; it was already stocked with game of every kind, and in all respects suited to be a hunter's paradise. Here he throve and multiplied, till the growing coldness of the on-coming ice time drove him south, at least beyond the Columbia River, and probably to California. The continent "was all before him where to choose, and Providence his guide." There were no enemies, save the *feræ naturæ,* and on them it was his delight as well as his business to make war. Though mammoths existed on the North American continent before the time of man, they were contemporary here in more recent times, for their remains have been found associated, in not very ancient alluvia, in many places.

At Hangman's Creek, Washington Territory, the bones of at least two species of the elephant were found in 1876, *Elephas americanus* and *E. primegenius*, and I think a third, to which I venture to give the name of *Elephas columbianus*, after the name of the great river near which the remains were found. They all appear to have been mired in a swampy part of the river bank, and were associated with a well-formed rough stone spear-head. From observations made in Europe, as well as in this country, human and mammoth remains were deposited together as recently as 8,000 or 10,000 years ago—perhaps even more lately. In regard to the greatest antiquity of these associated relics, Geikie, Pengelly, and other authorities, show that paleolithic implements and remains of extinct mammals have lain together in some of the European localities, where they are now found, for hundreds of thousands of years. We are unable to determine the antiquity of the associated remains of man and extinct mammals in America, but data, I think, are wanting for inferring with any degree of certainty that they are as ancient here as in Europe. There has been a great deal of dispute about the age of a human skull found in connection with mastodon bones beneath 140 feet of alluvium in Calaveras County, California. This Professor Whitney supposes to have been deposited there as far back as the pliocene of the tertiary; but the age of the alluvium is doubtful. From the abundance of fossil ivory found in Siberia and Alaska we may infer that elephants were once more numerous in those regions than they are now in Africa. This could have only taken place in that mild and genial climate that prevailed in high latitudes during the interglacial times.

During the tertiary geological period, and even subsequently, this continent seems to have been nearly upon an equality with the old world in regard to its animals, though it has more recently fallen behind in that respect, for in deposits of those times we not only find abundant remains of elephants larger than any now found in the old world, but of lions, tigers, camels, horses, rhinoceroses, hippopotami, etc., equal in size to any found elsewhere, besides fossil remains of large and wonderful animals that have not been met with beyond either ocean, some of which, from their formidable array of horns, Professor Marsh has arranged together under the name of the "dinocerata." The mammalian fossils of tertiary times brought to light by Hayden's surveys of Colorado, Utah, Wyoming, and other parts of the interior of our continent, have filled the scientific world with astonishment. Upwards of 100 species that the world knew nothing about before, have been discovered and described. Of species common to the two worlds, only those that could sustain a low temperature and migrate through the colder parts of the temperate zone, seem to have found their way into America. Camelopards and old world apes have not, I believe, been found here. It becomes interesting to inquire why every species of elephant, lion, tiger, camel, horse, rhinoceros, and hippopotamus should have died out on this continent, while they still retain a foothold in the old world.

I am inclined to refer the solution of this question to the fact that they were old world products. Called into existence by old world influences and surroundings, those of the new world were less congenial to them, and when the continents became severed, and they could no longer obtain an occasional importation of the parent stock to renew the blood and breed, they gradually deteriorated, and died out, just as, in fact, our stock raisers find to occur, who pay attention to the breeding of blooded stock. Unless the blood is renewed by the occasional infusion of new material from the old source, the breed degenerates. That the bear alone, of all the larger mammals of the tertiary and post-tertiary periods that have found their way to America, still maintains its old supremacy, in regard to size and ferocity, in the new world, is probably owing to the circumstance that the deep and almost inaccessible forests of North America afford it a more secure and congenial habitat than is commonly to be found on the further side of the Atlantic. The posterity of the gigantic *Ursus speleus*, that has long since degenerated or died out there, still exists, probably in the grizzly bear of the Pacific slope.

To Oscar Peschel we owe an explanation of the reason. Why the old world should be superior in its animal products—I mean, especially, its mammals. It exists, he supposes, in its greater size, it being many times larger than the new one. He says:

All who have studied the geographical distribution of forms of life have been struck by the fact that the old world is far richer than America in large animals. The largest animal in South America is the tapir, and the most powerful one of the northern continent is the grizzly bear. The elephant, rhinoceros, hippopotamus, and camel are wanting in the new world; but we find there the puma, ounce, alligator, and platyrhine apes with prehensile tails. Contrasted with these, we find in the old world the more noble lion, tiger, crocodile, and the anthropoid gorilla. Compared to the lion, the cowardly puma is contemptible. When the poet calls the lion the king of beasts, he expresses a happy thought. To this monarch belongs a truly royal domain, which, though now much curtailed, extends through all Africa and Western Asia. Next to this stands the tiger, or "royal tiger," as this fearfully beautiful animal has been properly named, who has half a continent for his dominion; for from the Caspian Sea it roams to the Amoor, where it extends its ravages to the frigid regions of the fur animals; while to the south, it penetrates to the farthest point of Asia, on the peninsula of Malacca, where it even swims over an arm of the sea and kills hundreds of men yearly on the little island of Singapore. The only feline in America that can be compared to the tiger is the smaller and far less courageous, though bloodthirsty, ounce, *felis onca,* which only attacks man when urged to do so by invasion or necessity. These contrasts have long since been noticed, and are enunciated in the old assertion that the new world is more favorable to vegetable and the old world to animal life.

These views have at least the merit of probability, and are confirmatory of those of Leopold Von Buch, who is entitled to the praise of having been one of those who prepared the way for Charles Darwin, as Kepler did for Newton. In his "Physical Description of the Canary Islands," he says, "The individuals of continental species extend themselves and form, with their increasing distance, varieties which at length by their great diversity cannot longer intermix with other varieties and be led back to the main type, wherefore they become permanent species." From this view we can see why a standstill in the struggle and consequent progress of life can occur but rarely, and for a short time only in large areas.

According to the views of the evolutionists, progress largely depends upon the struggle for life and survival of the fittest. It is obvious, as already shown, how this struggle would be more intense on large areas. It should not be looked upon as an evil, but rather as a good, because it inures to hardship and to strife, and forces individuals and species that have degenerated to resign the field to better organisms. It is the same thing in nature as free competition in civil life, that gives the progressive man the advantage and pushes aside him who lingers in the rear. On small secluded spaces, as, for instance, on islands, the struggle for existence is less active, being more limited in the diversity of its elements; in other words, the violence of the struggle increases with the space and the number of contestants; it has, therefore, been carried on the most strenuously in the old world, and in consequence the largest, strongest, and most intelligent beings have been produced there. These remarks do not apply to civilized man at the present day as forcibly as they do to lower beings, for commerce and intercommunication give to him all the world in common, and the new world and the old are as one. For him it is all one great battlefield, and to the victor belong the spoils. But for the savage, who comes in competition with him, woe betide him! Being the weaker, in spite of the teachings of philanthropy, he must succumb; that is, unless the civilization is a spurious one, that has enervated instead of strengthened its possessor, when the more vigorous barbarian may and should obtain the victory, as was the case in the struggle between the Turks and Greeks that resulted in the capture of Constantinople. Gibbon shows clearly how the Greeks were there defeated, and how and why they should have been.

The Maories of New Zealand recognize the inexorable march of events that must result from their contact with Europeans, and have summed up the matter in the following pithy sentence: "As the white man's rat has driven away the native rat, as the European fly drives away our own, and as their clover kills our fern, so must the Maorie disappear before the white man himself." There is much philosophy in this, for not only the white man has derived strength from the ages of intense conflict he has passed through, but also the lower animals and the plants have done the same.

Experience in the war of the Rebellion went to prove the fallacy of the common supposition that our Indian races have better constitutional powers of endurance than the whites, and that they are better able to stand up against fatigue, privation, and wounds. After Indian allies had been brought into the field in the cause of the Southern Confederacy, several regiments composed of Cherokees, Creeks, Seminoles, Omahas, and other tribes, were enlisted by the United States. Among these it was my fortune to serve in the campaigns of 1862 and 1863 in Arkansas, Missouri, Kansas, and Nebraska. I also had opportunities of seeing what kind of soldiers the negroes were capable of making. Of all, there can be no doubt that the whites were in every respect the most efficient, more especially in intelligence, courage, and endurance. It is equally clear to my mind that the negroes made better soldiers than the Indians, particularly in capability to withstand the effects of wounds. Of all, they recovered the best and quickest, and the Indians the worst and slowest. Among these last, too, constitutional ailments were the most common, and their wounds were the most apt to be followed by diffuse inflammation, suppuration, gangrene, and death.

Resemblances in the animal and vegetable products of tertiary periods, and those of to-day, show, I think, that the climates of the earth were then not widely different from the present. The lignites of the lower Columbia River region, results of the arborescent growths of the eocene, give evidence of the existence of timber there very similar to that now growing on the spot, and, consequently, of analogous conditions as to temperature and moisture. The firs, pines, and cedars of Oregon and Washington Territory are marvels of symmetry and magnificence. Shooting up to a height of 250 feet, often 200 without a branch, from five to eight feet in diameter, and straight as an arrow, they cannot fail to strike a beholder, unused to these forest giants, with wonder and delight. They glow in gloomy grandeur, marshaled side by side as thick as they can stand together, shutting out the rays of the sun, and preserving a continual dampness and twilight in the hottest and driest weather. Where overthrown by the warfare of the elements, their shattered trunks exude resin copiously, as a stricken soldier on the battle-field pours out his blood. There, too, their kindred giants of the eocene lie heaped together beneath them in lignite beds of an antiquity, compared to which the pyramids of Egypt are as things of yesterday; and, as they lie imbedded, they show, though changed to coal, marks of the same woody fiber, and the same resinous exudation, that the overthrown trees lying on the surface exhibit. Here and there in these coal-beds may be seen a tree that has become infiltrated with silicious matter and transformed to stone, still preserving a resemblance to the timber at present growing there, and showing its coniferous nature.

The carboniferous and tertiary coal deposits have an important connection with the introduction of the higher forms of life into the world. In the previous ages, when all the carbon that served to form these coals was mingled with the air and water in the form of carbonic acid, only low forms of life could be developed. Oxygen is a prime agent of vitality, and the more abundant it is, of course, the higher and more active will be its manifestations. The growth of vegetation is the result of the consolidation of the carbon of the atmospheric impurity and the liberation of the oxygen; and the rank vegetation that formed the carboniferous beds made the advance in animal life that characterized the succeeding age—the mesozoic, or reptilian—a possibility. An equally profuse vegetation preceded the tertiary coal formations, and prepared the way for the mammalian age, and doubtless the process still goes on and prepares the way for higher and higher forms of life. These are the two most extensive coal formations, and they were promptly followed by the greatest advances in animal life the world has seen, as far as we are instructed by geology. From the wide diffusion of these two coal formations over the North American continent, we may infer that even in those early times it was the favored home of vegetation, as it is at present.

With regard to the "Lost Tribes," that many of our good people delight to think and talk about, however completely they may have disappeared, and however long ago, so eager is the search, that "undoubted" traces of them are being from time to time "discovered;" and now they are sufficient to account for the population of half the globe. Among the latest of these "finds" is that of Rudolph Falb, a German professor, who, according to a San Francisco paper (the *Alta*), astonished the natives here, a short time since, by the announcement that, by long study and observation, he had been able to identify the Aymaras of Peru with the ancient Jews. Of all American tribes, the Aymaras are the darkest and most beardless, and possess the long, coarse, straight, and black hair of all the rest. A glance at the sculptures found by Mr. Layard at Nineveh and Babylon, that furnish us with the types of the pure and ancient Semitic race, would be sufficient, we should think, to convince any one that this high and noble branch of the human family, characterized by wavy hair, magnificent and curly beards, and a rather fair skin, cannot possibly be allied to the red man of America—most certainly not to the degraded, black, and beardless Aymara; nor is it possible, with any show of reason, to suppose that one of these races could have been transmuted into the other in the brief limits of three thousand years. These remarks are also, to some extent, applicable to other speculations of a similar nature to the above, for which see "The North Americans of Antiquity," by John T. Short, and other writings "too numerous to mention."

To-day all I thought of saying to you on this prolific theme, I fear, would extend my article to an undue length; though as it is, I have held myself in check. I will therefore conclude for the present by saying, as I intimated at the outset, a few words about the "mound builders" as a distinct race.

The architectural remains of the aborigines of that portion of North America now known as the United States, are found mostly in its eastern division. They consist for the most part, of mounds and earthworks of various forms and extent. They are scarce both in New England and west of the Mississippi, but are rather numerous from the Great Lakes down to Florida, on both sides of the Alleghanies, chiefly, however, on the west. I cannot, I think, do better than quote the brief remarks of Peschel on this head, which I incline to do, the rather as his work is but little known here. To be sure, a translation of it, from a London edition, was published by the Appletons some years ago, but Mr. E. L. Youmans writes me it has been but sparsely distributed. This I am surprised at, for though I consider the translation to be a poor one, the work itself is so excellent that it should be read and referred to by every one desirous of information on ethnology. The quotations here introduced are from the original:

The majority of American archæologists ascribe these works--the Indian mounds--to a supposed extinct race, to which they give the name of " mound builders." These they imagine to have wandered from Mexico toward the northeast, or from the northeast toward Mexico; but if these remains were nothing but a ray of the Nahautt civilization, they should occur more frequently the nearer we approach the highlands of the Ariahuac; but just in Texas all traces of them disappear, and there, as in Chihuahua, were seated, according to Cabeza de Vaca, very rude and half-starved tribes, who fed on fishes, roots, and the fruit of the prickly pear. The accounts of the Spaniards of the entrenched villages of the Indians in the former slave States, and the picture that Jacques Cartier has left us of the Iroquois city of Hochelaza, now Montreal, correspond sufficiently to the ideas we can form of those earthworks from the numerous ground plans and transverse cuts in Schoolcraft's voluminous work on the Indian antiquities of the United States. We agree entirely in opinion with S. F. Haven, who supposes these architectural remains to be the work of the ancestors of the present Indians. He has shown that a mound was erected over the body of an Omaha chief in the year 1801, and that there was found by Lewis and Clarke, on the upper Missouri, a whole row of recent entrenchments. Charlevoix informs us that the Iroquois, before his time, erected more extensive works than they have done since; so that they, as well as many other undeveloped races, may have neglected their old arts after their contact with a more advanced civilization. The builders of these rude earthworks were, we conclude, the ancestors of those hunter tribes who were ousted by the European settlers and their descendants. They lived then on the chase, and may have lived in the same way for untold centuries before the advent of the whites."

Mounds of earth and stones are the most primitive of structures; they are the dawning evidences of the constructive genius, and have been made in the first part of their advance from the lowest barbarism, by every people. Every Caucasian tribe or nation, whether Hamitic, Semitic, or Aryan, has in one part of its career thrown up mounds, and semi-savages of every race have manifested this propensity; indeed, so obvious is the device that it can scarcely be called an invention. It is an instinct incident to the very first step of human progress, and the pyramids of Egypt as well as the great mausoleum of the Monarch of Caria, at Halicarnassus, from whom (Mausolus) structures of this kind have received their name, however vast or elaborate they may have been made, are but advanced indications of the native impulse. It is mere folly to make the manifestation of a mere dawn of this propensity, as seen in our Indian mounds, the distinguishing characteristic of a race.

As the century approaches its termination science becomes characterized by a mode of reasoning based on observation and not on dreams. Her mantle should be kept whole, clean, and simple, and ethnology, as well as the other sciences, should no longer be degraded by the tawdry rags of fiction.

GLOSSARY OF TERMS

IN COMMON USE AMONG THE MINERS OF CALIFORNIA.

Prepared for the State Mining Bureau, by HENRY DEGROOT, Sr.

In compiling this glossary, we have drawn freely on that prepared several years since by Dr. Raymond, and presented, as a paper, to the American Institute of Mining Engineers. Some use has also been made of the list of mining towns appended to the work of Gregory Yale on "Mining Claims and Water Rights in California," and which, being the first of the kind published here, has since served, to some extent, as the groundwork of most that have followed. That the vocabulary might not be too full, we have included in it only such words and phrases as are in common use in the mining regions of the Pacific Coast, and some of which originated in and are peculiar to this section of country. While a few of these words and expressions are derived from the French and Spanish, the most of them are of English and California origin, their source in each case being indicated by the proper abbreviation. While some of the words credited to California are mere corruptions of others before in use, a few are entirely new, having been suggested by some incident or occurrence, perhaps, of a trivial kind, or being wholly the coinage of the miner's prolific brain. Some of these words, while they grate a little at first on the refined ear, are not without a certain aptness, and having for this reason first obtained currency they have at last, through long usage, become thoroughly legitimatized. During the earlier history of the State, Spanish names were more common in our mining nomenclature than at present, our Spanish speaking population in the mining regions having been much larger then than they now are:

A

Adit: A long, narrow nearly horizontal opening leading into a mine. In this country the term is usually synonymous with tunnel, though the latter, strictly speaking, means a passage through a hill and is open at both ends.

Adit-level: A tunnel driven for effecting the general drainage of a mine, being designed to receive and carry off the water both above and below its level.

Administrador, Sp.: Superintendent.

Administracion, Sp.: Management.

Adobe, Sp.: A sun-dried brick. Adobe soil, a black, tenacious clay.

Aggregated: Where the component parts only adhere together, and may be separated by mechanical means.

Ahonde, Sp.: Sinking or driving downwards.

Air Machine: A machine for forcing fresh air into and withdrawing bad air from a mine.

Air-pipes: Pipes for conveying fresh air into a mine.

Alta, Sp.: The upper part.

Alluvium: Earthy deposits made by running streams, more especially such as are left along their banks during high water.

Amalgamation: The process by which the precious metals are separated from pulverized ore by combining with quicksilver, from which they are again separated by heat or pressure.

Aparejo, Sp.: A pack saddle.

Apex: In the United States Revised Statutes, the end or edge of a vein on or nearest the surface.

Apron: 1. A canvas-covered frame set at such an angle in the miner's rocker that the gravel and water in passing over it are carried to the head of the machine. 2. An amalgamated copper plate placed below the stamp battery, and over which the pulp passing, the free gold it contains is caught by the quicksilver on the plate.
Arrastre, Sp.: A contrivance for crushing ores by dragging around in a circular bed a heavy stone attached to a sweep.
Arch: A piece of ground left unworked near a shaft.
Arroba, Sp.: Twenty-five pounds avoirdupois.
Assay: To test ores or minerals by chemical or blowpipe examination, the dry way when done by heat, the wet or humid when by liquid tests. An assay differs from a complete analysis in that it determines only certain ingredients in the substance examined, whereas an analysis determines everything it contains.
Ascension Theory: The theory that the matter filling fisure veins was introduced from below.
Assessment: The sum which the officers of a mining company levy on the stock held by shareholders. Assessment work is the work that the law requires shall be done annually to hold possession of a mine.
Auriferous: Containing gold.

B

Back: Back of a lode is the part nearest the surface: as applied to stope, drift, or adit the part of the vein between these and the next opening above them or between them and the surface.
Bank: The face of the coal at which miners are working; the ground at the top of a shaft. Ores are brought "to bank," *i. e.* "to grass," which see.
Bar: 1. A drilling or tamping rod. 2. A vein or dyke crossing a lode. 3. A ridge of sand, gravel, or rock running across a stream or river or across the entrance to the latter. 4. Accumulations of gravel along the banks of a stream, and which, when worked by the miners for gold, are called "bar diggings."
Barranca, Sp.: A ravine; a washout made by a heavy fall of rain.
Barrel Amalgamation: The amalgamation of silver ores by placing the pulp, mixed with quicksilver, metallic iron, and water, in barrels, which are then slowly revolved.
Base Bullion: See *Bullion.*
Base Metals: The metals not classed as noble or precious. See *Noble Metals.*
Basin: 1. A natural depression or strata containing a coal bed or other stratified deposit. 2. The deposit itself. 3. Cal., A depression that receives the drainage of the surrounding country.
Batch, Cor.: The quantity of ore sent to the surface by two men working in common.
Batea, Sp.: A wooden bowl in which auriferous earth or pulverized ore is washed.
Battery: The stamps that fall in one mortar—usually five.
Battery Amalgamation: Placing quicksilver in the stamp mortars.
Battery Assay: See *Pulp Assay.*
Bearing: See *Strike.*
Bed: A seam or horizontal vein of ore. A regular member of a series of formations, and not an intrusion.
Bedrock, Cal.: The solid rock underlying auriferous gravel or other surface formations.
Bedded vein: Properly, bed vein. A lode occupying the position of a bed—that is, parallel with the stratification of the inclosing rocks.
Beneficiar, Sp.: To work or improve a mine, reduce the ores, and derive profit from it. *Beneficiation,* in English, usually means the reduction of ores.
Black Alta: An argillaceous schist, found in the New Almaden quicksilver mine, Santa Clara County.
Black Damp, Eng.: Carbonic acid gas.
Blanket Sluice: Coarse blankets laid below the battery, over which the pulp passes. The fine gold is caught and retained in the meshes of the blankets. The latter are taken up frequently and placed in tubs of clean water, where the particles of gold are washed from them.
Blasting: 1. Shattering rocks or earth by means of gunpowder or other explosives. A blast means a single discharge of this kind. In blowing up the hydraulic gravel banks in California as many as 3,000 kegs of powder are sometimes used in one charge; a single blast of this kind shattering and partially displacing between three and four hundred thousand cubic yards of solid earth. 2. A blast means the continuous operation or blowing of a furnace in smelting one lot or batch of ore, or the work of a furnace for a season.
Blind Level: 1. A level not yet connected with the other workings of the mine. 2. A level for drainage, having a shaft at either end, and acting as an inverted syphon.
Blind Shaft: See *Winze.*
Blower: 1. A smelting furnace; a smelter. 2. A fan or other apparatus for forcing air into a furnace or mine.
Blowout: 1. A large outcrop, beneath which the vein is smaller, is called a blowout. 2. A shot or blast is said to blow out when it goes off but fails to do its work, or does it but partially.
Blossom: The oxidized or decomposed outcrop of a vein or coal bed, generally the latter. See *Gossan.*

Blue Lead, Cal.: The lower strata of auriferous gravel in the pliocene channels of California, stained a dark blue color by discoloring agents.
Bob, Eng.: The engine beam to which the pump rod is attached.
Bonanza, Sp.: Literally, fair weather at sea. A large body of rich ore in a mine. A mine is said to be in bonanza when it is yielding largely and profitably.
Booming, Cal.: In hydraulic mining the water, where scarce, is sometimes collected in a reservoir from which, when the latter gets filled to a certain point it makes its escape by means of an automatic gate. Recourse is had to "booming" where, owing to the scarcity of water, enough for washing by the hydraulic method cannot otherwise be obtained. In California these contrivances for collecting and discharging water are absurdly termed "self-shooters," an idea suggested by the sudden and violent manner in which the water, after accumulating in these receptacles, makes its escape.
Borrasca: Bad, stormy weather; hence, metaphorically speaking, bad luck—lack of good ore in a mine.
Bottoms, Eng.: The deepest workings.
Bottom Lift: The deepest lift of a mining pump, or the lowest pump.
Bowlder or Boulder: Fragments of rock, usually understood to be large and rounded in shape; though smaller stones of this kind are sometimes called bowlders.
Brakesman: The man in charge of a winding-engine.
Branch, Eng.: A small vein separating from the main lode, but with which, generally, it again unites.
Breast: The face of a working.
Buddle: An inclined vat or cistern, stationary or revolving, employed for concentrating and washing stamped ore with running water.
Bulkhead: 1. A partition in a mine for protection against fire, water, or gas. 2. A large wooden box placed at the lower end of a ditch or flume for receiving the water and emptying it into the iron pipes which convey it to points where required for use.
Bullion: Uncoined gold or silver. On the Pacific Coast, pig lead containing silver and a little gold, is termed *base bullion.*
Burro, Sp.: An ass, a jack; a hand-whim, a windlass.
Buscons, Sp.: Miners who work on part proceeds; tributers.

C

Caballo, Sp.: A horse; which see.
Caché (pronounced *cash*), Fr.: The place where provisions, ammunition, etc., are *cached,* or hidden by trappers and prospectors in regions where there are no white settlers with whom these articles could be left, or from whom fresh supplies could be obtained.
Cage: A box or platform used for hoisting men, tools, material, etc., from, and lowering them into a mine.
Campo, Sp.: A camp, a field; a working in the possession of Buscones.
Cañon, Sp. (pronounced *canyon*): A precipitous valley—a gorge. In some parts of the United States the term *hollow* has a similar significance, being applied to a ravine or valley. As this word has become thoroughly Anglicized, it might as well be spelled *canyon,* as pronounced; an orthography that by many writers has been adopted.
Captain: Foreman or overseer of work in a mine.
Carbon, Sp.: Charcoal.
Carga, Sp.: A mule load of 300 pounds.
Casing: A stratum of material altered by vein-action and lying between the unaltered country rock and the lode—sometimes called the selvage, lining, or gouge. See *Gouge.*
Caving: The falling in of the sides or top of excavations.
Cement: Indurated gold-bearing gravel, hardened and held together chiefly by a silicious mixture.
Cerro, Sp.: A hill or mountain.
Charge: 1. The quantity of powder or other explosive used at one blast. 2. Quantity of material for one working in pan or settler.
Chilian Mill: A style of *arrastre* in which a heavy stone wheel affixed to the end of a shaft is rolled round in a trough.
Chimney: An elongated body of ore standing in a lode or ore channel.
Chlorides: Ores containing the chloride of silver.
Choke Damp, Eng.: Carbonic acid gas.
Chute: 1. An underground inclined winze, or an inclined trough above ground, through which gravel, ore, etc., is sent down; "shot" from a higher to a lower level. 2. Ore chute. See *Chimney.*
Claim, Cal.: The quantity of mining ground that one claimant or association is permitted to hold under the federal and local laws by virtue of one location and record. Sometimes termed a location, mine, etc.
Clean-up: The operation of collecting the gold or silver taken out during a single "run" of a stamp mill, hydraulic, or drift claim.
Cobre, Sp.: Copper. Copper ores from Cuba and South America.
Coffering: Securing the shaft from an influx of water by ramming in clay.
Concentration: The removal of the lighter and less valuable portions of the ore by mechanical means. Concentrations are the more valuable portions of the ore so obtained.

Concentrator: The machine with which, through the aid of air, water, magnets, or specific gravity, the work of concentration is effected.
Conducta, Sp.: A convoy for the safe conveyance of bullion or coin overland.
Contact: The plane between two adjacent bodies of dissimilar rock. A contact vein is one standing or lying between such dissimilar rocks.
Colliery: A coal mine.
Color: The fine particles of gold obtained by the "prospector" in washing a sample of auriferous gravel or crushed ore, so little, generally, that being unable to weigh it, he estimates its value by the eye.
Copper Plates, Cal.: Plates of copper covered with quicksilver, over which the pulp from the batteries is allowed to flow, the gold being caught by the quicksilver.
Country: The rock traversed by or adjacent to a lode or ore deposit.
Course: See *Strike.*
Coyoting, Cal.: Searching after or taking out ores in a desultory way. Making irregular holes like the coyote, a species of small California wolf.
Cropping Out: The rising of ledges of rock to the surface. That part of a vein which appears above the surface is called the cropping or outcrop.
Cross-course: A mineral vein that intersects or crosses another at whatever angle, and which is very apt to fault the latter, or throw it out of its regular course.
Cross-cut: A drift or level driven at right angles to the course of the lode.
Crushing: Pulverizing the ore with stamps. The quantity of ore so pulverized or crushed at a single operation.

D

Debris: 1. Rocky or earthy fragments. 2. The silt, sand, and gravel that flow from the hydraulic mines; called in miner's parlance, tailings, slums, and sometimes by the outlandish name of "slickens." (Which see.) See also *Tailings.*
Dead, Eng.: 1. Unventilated. 2. As to a vein or piece of ground, unproductive.
Deads, Eng.: Attle or rubbish, the waste rock packed in excavations from which ore or coal has been removed.
Deadened Mercury: See *Floured.*
Dead-work: Work not directly productive, though necessary for exploration and future production; detritus.
Deposit: The term *mineral deposit,* or *ore deposit,* is used to designate the natural occurrence of a useful mineral or ore sufficiently rich and extensive to warrant its being worked.
Descension Theory: The theory that the mineral in veins entered from above.
Die: A piece of hard iron placed in a battery to receive the blow of the stamp, or in a pan to receive the friction of the muller.
Diggings, Cal.: The placer mines.
Dip: The inclination of a vein or stratum below the horizontal.
Discovery: The first finding of the mineral deposit in place upon a mining claim. Under the U. S. law such discovery is necessary before the claim can be held by a valid title.
Drift: 1. A horizontal passage underground following the vein and therein differing from a cross-cut, which intersects it, and from a level or gallery, which may do either. In placer mining drift claims are opened by means of shafts or tunnels, through which the auriferous gravel, after being drifted or broken out with picks, is brought to the surface. 2. *Unstratified diluvium.*
Drawing: In hydraulic mining—throwing the water beyond the dirt to be removed and causing it to flow toward the giant.
Drive: To extend an excavation horizontally. Distinguished from sinking and raising.
Dump: 1. To unload a vehicle by tilting or otherwise. 2. A pile of ore or waste rock. 3. Cal. The fall immediately below a hydraulic mine.

E

Elvan, Eng.: Porphyry, claystone.
Escaleras, Sp.: Ladders; notched timbers for descending into and ascending from mines.
Exploitation: The productive working of a mine, as distinguished from exploration.
Explosives: The principal explosives used in mining are gunpowder, nitro-glycerine, dynamite, hercules powder, tonite, etc. For forming these explosives, exploders, being caps filled with the fulminate of mercury, are used.

F

Face: The end of the adit, tunnel, or stope where work is going on or was last done.
Fan: See *Blower.*
Fault: A dislocation of the strata or the vein.
Feeder: A small vein joining a larger vein.
Fire-damp: Light carburetted hydrogen gas, and which, when present in common air to the extent of one fifteenth or one thirteenth by volume, the mixture is explosive.
Fissure Vein: A fissure in the earth's crust filled with mineral.
Flask: An iron bottle containing seventy-six and one half pounds of quicksilver.

Float Gold, or Flour Gold: Particles of gold so small and thin that they float on and are liable to be carried off by the water.
Float Ore: Water-worn particles of ore; fragments of vein matter found below and often some distance from the vein of which it originally formed a part.
Floured: The finely granulated condition of quicksilver, caused to a greater or less extent by its agitation during the process of amalgamation.
Flume: A wooden race for the conveyance of water.
Foot-Wall: The upper surface of the rock that lies under the lode or vein; also called the lower or underlying wall.
Formation: See *Geological Formations.*
Free: Native; uncombined with other substances, as free gold or silver.
Free Milling Ores: Ores in which the precious metals, being free from combination with other substances, can be reduced by crushing and amalgamation without roasting or other chemical treatment.
Frijoles, Sp.: French beans; also kidney beans.

G

Gad: A small iron wedge, used for splitting rocks.
Gallery: A level or drift.
Gang: A set of miners.
Gangue: The mineral associated with the ore in a vein.
Geological Formations: Groups of rocks of similar character and age are called formations.
Giant: A hydraulic nozzle.
Giraffe: A car made to run on an incline.
Goosing, Cal.: In hydraulic mining, driving the gravel forward with the stream from the giant—the reverse of drawing, which see.
Gopher, Cal.: To seek for or extract ore in an irregular way.
Gouge: A layer of soft material along the wall of a vein.
Granzas, Sp.: Poor ores.
Grass, Grass Roots, Eng.: The surface over a mine; to bring ore to *grass,* is to bring it to the surface.
Grizzly, Cal.: An iron grating that catches the larger stones passing through the sluices and throws them aside.
Ground: The rock in which a vein is found; also, a portion of the mineral deposit itself.
Guixa, Sp.: Quartz.
Gulch, Cal.: A narrow mountain ravine; a small canyon. This would appear to be a corruption of the word *gulf.*

H

Hanging-wall: The wall or side over the vein.
Heading: The vein above a drift. See *Back.*
Heave: A horizontal dislocation of a vein or stratum.
Horn Spoon: A longitudinal section, cut from the under side of an ox horn and scraped thin: used for washing auriferous gravel and pulp where delicate tests are required.
Horse: A mass of country rock inclosed in an ore deposit which has fallen from the wall of the fissure.
Horse-gin: Gearing for hoisting by horse-power.
Huel, Eng.: See *Wheal.*
Hungry: Hard, barren vein matter, like white quartz.
Hurdy-gurdy Wheel: A water-wheel propelled by the direct impact of a stream of water upon its paddles.
Hushing: Discovering veins by suddenly discharging a quantity of water which, washing away the surface soil, lays bare the rock.
Hydraulicing, Cal.: Tearing down and washing the gold-bearing gravel with water discharged upon it from iron pipes, and under great pressure.

I

Impregnation: An ore deposit consisting of the country rock impregnated with ore; usually without definite boundaries.
Incline: 1. A shaft not vertical, usually on the dip of the vein. 2. A plane, not necessarily underground.
Infiltration Theory: The theory that a vein was filled by the infiltration of mineral solutions.
Ingenio, Sp.: Engine.
Injection Theory: The theory that a vein was filled first with molten mineral.
In Place: Rock, ore, etc., occupying the position or place in which they were originally formed.
Intendente, Sp.: Superintendent, overseer, chief.

J

Jigging, Eng.: Separating ores, according to specific gravity, with a sieve or jigger agitated up and down in water.
Jump, Cal.: To take possession of a mining claim on the supposition that it has been forfeited or abandoned.

K

Kibble, Eng.: An iron bucket for raising ore.
Killas, Eng.: Clay slate.

L

Lagging: Planks, slabs, or shakes placed over the caps or behind the posts of timbering to prevent the earth or fragments of rock falling through into the shaft or tunnel.
Lead (pronounced like the verb *to lead*): See *Lode.*
Leader: A small vein leading to a larger one.
Ledge: See *Lode.*
Level: A horizontal passage or drift into or in a mine. It is customary to work mines by levels in depth, numbered in their order below the adit, or drainage level, if there be one. On the Pacific Coast levels are numbered from the surface down.
Little Giant: A jointed iron nozzle used in hydraulic mining. See *Giant.*
Lode, Eng.: A fissure in the country rock filled with mineral. The terms lode, vein, and ledge are used indiscriminately.

M

Maiz, Sp.: Indian corn.
Maquina, Sp.: A machine.
Matrix: The rock or earthy material containing a mineral or metallic ore; the *gangue.*
Measures: Strata of coal, or the formation containing coal beds.
Metal, Sp.: Metal, ore.
Mineral, Sp.: Ore, mineral.
Mill: An establishment for reducing ores by other means than smelting; a machine for crushing ore.
Mill-run, Cal.: The work done by a mill between two clean-ups; test of a lot of ore by working it in a mill.
Mine: In general, any pit or excavation made for minerals, more strictly, subterranean workings, as distinguished from quarries, placer and hydraulic mines.
Miner's Inch of Water: The miner's inch of water does not represent a fixed and definite quantity, being measured generally by the arbitrary standard of the various ditch companies who have to sell. Generally, however, it is accepted to mean the quantity of water that will escape from an aperture one inch square through a two-inch plank, with a steady flow of water standing six inches above the top of the escape aperture, the quantity so discharged amounting to 2,274 cubic feet in twenty-four hours.
Mineral: In miner's parlance, ore.
Monitor, Cal.: A style of nozzle used in hydraulic piping.
Mortar: 1. A deep iron dish, in which ore is crushed with a pestle for sampling or assaying. 2. In stamp mills the iron trough containing the dies on which the stamps fall and crush the ore.
Mother Lode: The principal lode or vein passing through a district or particular section of country.
Muller: The iron shoes dragged around in an amalgamating pan to mix and further pulverize the pulp.
Mundic, Eng.: Iron pyrites.

N

Native: Occurring in nature. Pure metal—as native copper, etc.
Noble Metals: Metals that have so little affinity for oxygen that they do not readily become rusty. The list includes gold, silver, mercury, and the platinum group.

O

Obra, Sp.: Workings.
Oil Well: A well dug or bored, from which petroleum flows or is pumped.
Open Cut: A surface working, open to daylight.
Open Work: A quarry or open cut.
Oro, Sp.: Gold.
Oroche, Sp.: Electrum; natural alloy of silver and gold.
Ore: A natural mineral compound, of which one at least of the elements is a metal.
Output: The product of a mine.
Outcrop: See *Cropping.*

P

Panning, Cal.: Washing auriferous gravel in an iron pan made for the purpose, to obtain the gold it contains.
Patio, Sp.: Amalgamation floor.
Pay Streak, or Pay Gravel: In placer mining, a rich strip or lead of auriferous gravel; the zone in a vein which carries the profitable or pay ore.
Peso, Sp.: A dollar; any weight.
Peter, or Peter-out, Cal.: To fail gradually, in size, quantity, or quality.
Pico, Sp.: A miner's pick.
Piedra, Sp.: A stone.
Pillar: A piece of ground or mass of ore left to support the roof or hanging wall in a mine.
Pinch: To contract in width.
Pipe Clay: Masses of fine clay, generally of lenticular form, found imbedded in the hydraulic gravel banks.
Piping, Cal.: In hydraulic mining, discharging water from the nozzles on the auriferous gravel.
Pipe-vein: An ore body of elongated form.
Pit: A shaft; in hydraulic mining, the excavation in which piping is carried on.
Pitch: The inclination of a vein or of the longer axis of an ore body.
Placer, Sp.: Ground of alluvial or diluvial origin, containing gold, tin, precious stones, etc., which are obtained by washing such ground with water.
Plunger: The piston of a force-pump.
Pocket: A rich spot in a placer mine or a small rich body of ore.
Precious Metals: See *Noble Metals.*
Prospecting: Searching for new mineral regions, new mines, or bodies of ore; also preliminary explorations to test the value of lodes or placers.
Pull-up Stakes, Cal.: To strike camp. To remove from one place to another, as in search of new diggings, etc.
Pulp, Cal.: Pulverized ore. A pulp assay is any assay of samples of ore taken from a mill crushing.
Pump Station: See *Station.*

Q

Quarry: An open or "day" working—usually for the extraction of slate or stone.
Quartz: Crystalline silica; any hard gold or silver ore as distinguished from earth or gravel.

R

Ranch, Sp. *Rancho:* A tract of land—farm, estate, residence.
Reef, Eng.: See *Lode.*
Riffle: A cleet or groove in the bottom of a sluice to hold the quicksilver and catch the free gold.
Rise: A shaft or winze excavated upwards.
Rocker: A "cradle;" a short trough provided with hopper, apron, riffles, etc., for washing auriferous gravel.
Roof: The rock overlying a bed or flat vein.
Run: The length of time reduction works or a hydraulic mine is kept in operation without stopping to clean up, make repairs, or for other purposes. See *Clean-up.*
Rush: A sudden movement of a large number of miners to some new locality. See *Stampede.*
Rusty Gold, Cal.: Free gold, which does not readily amalgamate, the particles being covered with a silicious film, thin coating of oxide of iron, etc.

S

Safety Cage: A box or platform used for lowering and hoisting miners, tools, etc., into and out of mines, and which is provided with a "safety clutch," an automatic device for preventing the fall of the cage if the supporting cable breaks.
Safety Lamp: A lamp, the flame of which is so protected by wire gauze that it will not readily ignite fire-damp.
Saline: A salt spring, well, or bed. Salt works.
Screen: A sieve of wire-cloth or perforated sheet iron used to sort ore and coal according to size. Stamp mortars have screens placed at the sides, through which the pulp escapes.
Seam: A thin stratum of coal or other mineral.
Segregation: A mineral deposit formed by concentration from the adjacent rocks.
Selvage or Selfedge: A layer of clay or decomposed rock along a vein wall. See *Gouge.*
Shaft: A pit sunk from the surface.
Shift: The length of time a miner works in one day; the gang of men working for that period: as the day shift, the night shift.
Shoe: A piece of iron attached to the bottom of a stamp or muller, and which can be replaced when worn out.

Slickens, Cal.: This word is sometimes used to designate the debris, or tailings, discharged from the hydraulic mines. It is alike superfluous, absurd, and senseless, belonging to that category of singular, not to say outlandish terms, such as "peers like," "peart," "right smart chance," and similar phrases, imported into California from the southwest, a soil prolific in lingual abnormities. This appellation, however, while it has all the inelegance, lacks the originality, force, and significance that generally characterize the class to which it might otherwise be properly referred. Instead of recognizing and incorporating these barbarisms into our mining nomenclature, it would be better to relegate them to the obscure and unintelligent sources whence they came; since a too free intergrafting of such phraseology upon our mother stock cannot fail to both weaken and degrade it.
Slimes: The most finely crushed ores.
Sluicing: Washing auriferous earth through long races or boxes, provided with riffles and other gold-saving appliances, and called sluices.
Slums: The discharges from the hydraulic mines. See *Tailings*.
Spur: A branch leaving a vein but not returning to it.
Stack: A chimney.
Stamp-mill: A mill where ores are crushed under stamps.
Stoping: Taking ore from a vein by driving horizontally upon it a series of workings, one immediately over or under the other.
Strike: 1. The direction line, drawn in the middle plane of a vein or stratum not horizontal. 2. Coming upon a rich deposit in working a mine or stringer.
Sobrante, Sp.: Residue, overplus, surplus, profit.
Stampede, Sp.: A sudden emigration or movement of large numbers of miners, impelled by reports of new diggings or rich mines discovered elsewhere. See *Rush*. This word is derived irregularly from the Spanish verb *estampar*, to leave foot-marks; or, more likely, from the noun *estampida*, to run away in debt. If from the latter, however, its meaning, as here applied, has been sadly perverted; it never having been the habit of the California miner, however hastily he might "pull up stakes" and "scurry" away to some distant locality, to leave his creditors in the lurch.
String: A small vein.
Strip: To remove from a ledge or quarry the overlying earth, loose rocks, etc.
Sublimation Theory: The theory that a vein was filled first with metallic vapors.

T

Tailings. Cal.: The debris, detritus, or slums discharged from the hydraulic mines, and which consist mainly of silt, sand, and gravel, intermixed with the water that carries them off.
Tail Race: The channel in which tailings suspended in water are conducted away.
Throw: The dislocation of a vein or stratum, which has been thrown up or down by the movement of the earth.
Tiro, Sp.: A shaft.
Tiro Generale, Sp.: The principal shaft.
Tribunal de Mineria, Sp.: Mining tribunal.
Tributors: Miners who receive for their labor a certain portion of the ore they take out, or of its proceeds.
Tunnel: See *Adit*.

U

Undercurrent: A large flat box or platform, placed beside and a little lower than the main sluice, from which it receives a portion of its contents, and carrying them to the lower end of the undercurrent there returns them to the sluice. This apparatus is paved and riffled like the sluice, but being much wider than the latter, allows the water to spread out in a thin sheet over its surface, thereby so abating the force of the current, that the very fine gold, including the rusty particles, are more apt to be caught here than in the sluice.
Underlie, or Underlay: The departure of a vein or stratum from the verticle. See *Dip*.
Unwater; To take the water from a mine.
Upcast: The opening through which the ventilating current passes out of a mine. The reverse of downcast.
Uprise: See *Rise*.

V

Vanning: 1. Washing ore on a shovel analogous to panning. 2. Concentrating machines are called vanners.
Vapor, Sp.: Steam, vapor. Foul air in a mine. A steamship or boat.
Vein: See *Lode*.
Veta, Sp.: A vein or lode.
Veta Madre, Sp.: See *Mother Lode*.

W

Wall: 1. Side of a level or drift. 2. The country rock bounding a vein latterly.
Washer: See *Rocker*.
Water Level: The level at which, by natural or artificial drainage, water is removed from the mine.
Weathering: Changing under the effect of continued exposure to atmospheric agencies.
Wheal, Eng.: A mine.
Whim: A machine for hoisting by means of a vertical drum, revolved by horse or steam power.
Whip: A rope passed over a fixed pulley for hoisting with an animal.
Win: To extract ore or coal.
Winch, or Windlass: A man-power hoisting machine in which the rope is wound on a shaft or drum worked with crank handles.
Winze: An interior shaft, usually connecting two levels.
Workings: The various means whereby a mine is opened and worked, as shafts, stopes, levels, tunnels, etc.
Working Home: Working towards the main shaft in extracting ore or coal; the reverse of working out.

Zanja, Sp.: A ditch, a trench.

APPENDIX.

PAPERS SUPPLEMENTARY

TO THE

REPORT OF THE STATE MINERALOGIST.

1. Forest Trees of California.
2. Notes on Hydraulic Mining.
3. Hydraulic and Drift Mining.
4. On the Milling of Gold Quartz.
5. Rare Minerals recently found in the State.

FOREST TREES OF CALIFORNIA.

By A. KELLOGG, M. D.

FOREST TREES OF CALIFORNIA.

CALIFORNIA NUTMEG TREE.

(*Torreya Californica.*)

"Low whispering through the shade."—*Barbauld.*

This very charming evergreen tree is one of the most fascinating of all the Yew family. Some, perhaps, are more grand and imposing, as the Kakaterro (*Dacrydium taxifolia*), of New Zealand; or elegantly fan-form and fernlike in foliage as the Ginko (*Salisburia adiantifolia*), and others of Asia. Our false nutmeg-like yew, and kindred species, so highly extolled and appreciated for beauty, are only separated from other more strictly coniferous trees by their fruits not being collected into cones, each seed growing singly by its independent self and not protected by hardened scales, although sometimes in clusters of several. They are, nevertheless, in a similar manner resinous. These trees have also the general appearance and habit of conifers. From the most ancient times, all the *Taxads* have been celebrated for their remarkable firmness, durability, and great elasticity—held in highest renown for the primeval weapons of war—wars are still waged for their possession in the isles afar off, both for their bows and for their idols, and by the common consent of all mankind the timber is considered the best known in the world; our own appear to be no exception to the rule.

The California Nutmeg Tree towers in the coast forest, eighty to one hundred feet high; clean trunk of forty feet, straight as an arrow, and four feet in diameter. As more commonly seen, it is of moderate stature, say forty to sixty feet high by about two to three feet through. Wholly exposed, or partially, on the margins of woodlands, it may become smaller and more round-headed.

The leaves, from a yew point of view, are long, two to two and one half inches, narrow and line-like, rigid and flat, with very sharp awl-pointed or prickly tips, color rather dark shining green, arranged in two rows, one on each side of the twigs, after the usual way of yews, spruces, and firs. These little branchlets divide by threes and fours flat fan-spread—the principal large branches, whirled around the main body; this wheel-branch feature is apparently lost in age or cloaked over as the top closes in and becomes full with myriads of soft drooping and flexible sprays—so surprisingly foreign to its earlier growth. At the first glance, one can scarcely realize this to be the same prudish Nutmeg Tree known before or elsewhere. Arrived at this maiden condition, the charm of her changes grow upon you, in many ways, amazingly; yet withal, in the highest degree pleasing—from the former stiff and formal foliage, or merely symmetrical branch and twig—the ever-vernal glossy tresses, in varied beauty, now begin to hang gracefully from head to bosom, festooning the boughs and thickening-in the whole foliaceous expanse. This results, in a degree, from the natural persistence of leaves very far back on the branchlets; besides, the rigid two-rowed feature, mentioned before, becomes less strictly observed; it thus lightly thickens while it is not at all heavy, notwithstanding the rather dark deep varnished green mantle, but maintains a very tasty flossiness fully equal to the most graceful forms of Sitka Spruce (*Picea* [*Abies*] *sitchensis*), and only inferior in extent to the marvelous pending curtain-corded wreaths of the most elegant types of Douglas Spruce (*Pseudotsuga* [*Abies*] *Douglasii*); thus we view it common to kindred trees scattered over the western of half the continent of North America (by actual personal observation), comprising nearly all climes and conditions of the Pacific. Hence, in most cases, we conclude all that is peculiar is altogether caused by improvised richness superadded to favorite natural conditions of clime and soil; *e. g.* near recent rural residences or old deserted Indian villages or lodges, etc. The Nutmeg Tree thus standing on very fertile soil, and more out from the wood, as observed, where it greets the sun face to face the livelong day, the rigid, flat, precise, and formal Norfolk Island Pine style of open wheeled branch, tier above tier, is merged from the masculine, towering and aspiring top, into the humbler head of modest maidenly beauty, crowned in this delicate sheen of verdure, the transformed tree so captivates the beholder one can scarcely, with much effort, withdraw the spell-bound gaze; the reluctant eye, constantly returning, will fondly linger in painful pleasure at final parting with this pretty belle from the bowers of Paradise.

A large tree formerly grew on Papermill Creek, in Marin County, of which we preserve a sketch, for, alas! the vandals have long ago laid it low. A small typical tree may be seen at Mr. Harvey's, just outside his field fence at the bar-way entrance, close on the Santa Cruz roadside, fourteen miles below Pigeon Point. We have not the pleasure of this gentleman's acquaintance—never saw him—but took special pains to find out his name many years ago, that we might remember him in our prayers and blessings so long as we live, and for ever after, for preserving that beautiful tree. But perhaps the grandest California Nutmeg Tree known on the coast is that near Duncan's Mills, in Mendocino County, over one hundred feet by four, forty feet of clear shaft, and straight as an arrow from the bow of the Great Archer himself; sound and flourishing in all vigor, with spreading top, rejoicing and ready as a strong man to run a race: well worth a pilgrimage to behold, in its glory; a noble and living witness that some lumbermen have sylvan consciences; may these and their shadows never be less.

Loth to leave the subject, a few words of descriptive detail and a general remark must close this preliminary notice. The bark is even, of darkish color; fruit solitary, or rarely clustering, close set, pending from the underside of the twigs, obovoid or oval, nearly two inches long by one and one quarter in diameter, plum or somewhat fig-shaped, when divested of greenish longitudinally watermelon or pepo-striped thick skin-like flesh the inside meat-structure of the oblong nut or kernel cut transversely across, resembles the internal structure of a nutmeg, hence the common name; and thereupon many foolish vagaries, bandied about by ignorance.

This tree extends from coast to sierra, up to at least four thousand six hundred feet near Yosemite Valley, as finely flourishing as here on the coast, but never in extensive groves; rarely in sociable numbers, often scattered, and rather rare. Found also in the southern Atlantic States, China, and Japan, but distinct species from that in California. There is not the slightest unpleasant odor in handling this tree, and to perpetuate such scandal by gratuitously foisting an obnoxious name—never known nor heard of save from some unreliable sources abroad, and echoed by Eastern ignorance—is deplorable. With some it certainly cannot be an effort to calumniate both men and things, in one fell swoop, reminding one of recoiling "total depravity," therefore are we fain to consider it one more instance in the long list of sins to be winked at.

PACIFIC YEW.

(*Taxus brevifolia.*)

"Bows of the tough yew."—*Virgil.*

A tree forty to sixty, or even seventy-five feet high, one to two, rarely three feet in diameter; usually broadly conic in outline, sometimes more aspiring, but always of arboreal habit; body with a strong base, often unsymmetrically developed, or measuring one fourth to one third more in one diameter than another, covered with a flaky, thin, dark cherry-red bark, rarely a little shreddy; long and slim branches, horizontal or slightly depending; twigs slender, in flat fan-formed sprays, the shining green leaves closely set on very short tiny leaf-stems, arranged strictly in two rows, like redwood, hemlock, and trees of similar foliage, but rather darker, or richer, and much more glossy varnished green, about three fourths of an inch long, flat, line-like, and sharp pointed, a shade of lighter yellowish-green beneath. The fruit is most charmingly ornamental, set underneath the finishing sprays in bright translucently red fleshy cups, the oblong cone-topped seed imbedded therein. This pretty pulpy cup is quite sweet and fruity; in short, edible.

Our Yews are certainly not yellow-green, neither are they sombre; for, first, the form is so free, open, and airy, and the foliage such a cheerful shining green, that it has altogether a vivacious effect; but were it dismally dense and formal, or dully dark and dirty in hue of bark, leaf, flower, or fruit, or stiff and heavy in any apparent sense, we might possibly, in some implied way, indorse, or at least copy, public sentiment. But, reader, if you please, put a beautiful sprig of it in our bouquet, cheery rubied fruit and all, and let it spirit us to the sweet spruce woods once more, happy as any child this side Eden. Should any say, "It's in bad taste," why, then, we must refer them to the wise proverbs of gray antiquity, which declare there is no disputing about such matters, for they belong chiefly to that higher realm of yea, yea, and nay, nay. At all events, let us agree that the conic form, when duly open and free, is the lightest, as in this case noted, nor dwell long on the lengthened careless toss of horizontal branch, and not too thickened spray, but winged with bright perpetual verdure, perfect integrity of form, storm-proof against all ordinary contingencies, or with ready and vigorous replacement; tolerant of the most rigorous discipline, and patient of the greatest abuse; bright with those precious gemmed fruits in long succession, and that longevity "wherein the memory of man runneth not to the contrary." We say these, with unnumbered considerations, will forever commend the Pacific Yew to our high estimation.

Although Homer and Virgil speak of "bows of the tough yew," they were not mentioned in English history until the time of the Saxons, when the wood became so popular as to be quite exhausted in many countries. Modern recreations of elite archery are largely and profitably reviving the old demand; the timber is now already being transported East, and exported abroad. The matured heart-timber is deep red, or beefsteak-colored, hard, heavy, and apt to be brittle if at all short or cross-grained; makes excellent pullies, friction-rollers, boxes, gudgeons, and for turning purposes in general is exceedingly valuable. Our species, at least, seems to stand well, for if half buried will slowly weather-wear away, but still keeps its size and soundness below for ages. No doubt there are preferred sections in this as in all other timbers. The boughs, within moderate limits of tension, have the quick snap and short twang for the bow, like its renowned congeners, and have ever been used by the natives here as of yore, and by young America even unto our day. But some of our native tribes seem to prefer the willow-root bow for the belly, sinew-lined on the back; ash for arrows, or the shoots of *Tessaria borealis*. The Latin name *Taxus*, is supposed to be derived from the Greek *Toxon*, a bow. It should be added that the bark is clean and thin like madrona, sycamore, manzanita, and all such like trees, as together with Yew, flake off the old, and renew their exterior bark every year. The flowers—male and female—are found on the same tree; staminate, or males, in little heads seen solitary springing from axillary scaly buds, the yellow anthers standing out, shield or parasol-shaped, with six to eight folds or cells opening beneath; the female, green, broad-scaly, at first like a tiny acorn, fairy cup and all, the upper united scale or rather bractoid base, at length thickening into a nest-like ruby red coroloid fleshy cup, the rim of which often becomes higher than the little nut-like seed that sits so pertly in it.

The Pacific Yew is never naturally degraded, groveling low upon the ground, like the disconsolate Eastern one; and if we must needs personify it, like the true child of nature, or the barbarous Indian, then let it be to him the "fighting wood," because he maketh of it the death-dealing bow. But to our more genial eye, it rejoices in a song of freedom and recreation, above, among the trees of the forest, apter emblem of more elevated and cheerful views of life, or death, if you will, as only another and higher step or birth in life, instinct with joy and gladness and the voice of melody.

Found in the whole coast range of California, and so northward to the Cascades in Oregon, and to our Sierras, growing along cold, shady creek banks, and in damp ravines and deep gorges, often in considerable numbers, as on Yew Creek, in Mendocino County and elsewhere, but never in groves.

LAUREL HAWTHORN, OR TOYON TREE.

(*Heteromeles* [*Photinia*] *arbutifolia.*)

"Mark the fair blooming of the hawthorn tree,
Finely clothed in a robe of white."—*Wm. Browne.*

Kindred to the renowned Rowan Tree (*Pirus aucuparia*), and sacred to somewhat similar associations, few denizens of the wild woods possess greater interest than the Toyon tree, or Laurel Hawthorn. A shrub, or small tree, five to twenty-five feet high, from a few inches to a foot in diameter; leaves thick and leathery, oblong or elliptical, lance-like, sharp at the ends, and sometimes at the base, two to four inches long, half an inch or more broad; leaf-stem stout and short, margins saw-toothed, the shallow teeth sharp, usually tipped with a gland, color sap-green above, and lighter yellowish-green beneath. Seen abroad, along the sandy coast, it is more dusty and sombre; but massed or clumped on our hillsides, bending over the brow of the cliff, or perched on the point of rocks looking seaward, this winter-green shrub glows in livelier, lighter hues than oaks, and a thousand other surrounding foliage; this becomes still more conspicuously manifest as it climbs the dry hills, and is again altogether a rounded shrub. The numerous little white flowers, Hawthorn-like, or less than half an inch across, are in large compound clusters of a span or so, on the ends of sturdy twigs; petals or flower leaves are roundish and slightly scolloped, on short claws; five-toothed cup, short and thick, becoming still more thickened and imbedded on the end of the fruit, like partridge berries, or tiny twin berry (*Michella*), huckleberries, wintergreen, etc.; stamens, ten—two opposite each tooth; central styles two, more or less united; at length the bright scarlet berries, which all along late Summer and Autumn, have been a little turbaned, or remotely pear-shaped, swell out nearly globular, and are less oblong. These are usually about the size and color of winter-green berries (*Gaultheria procumbens*); in the recent state these beautiful berries have but little odor, but when dry the piquant spicy odor is exceedingly refreshing, and nothing is more lasting, abiding still fragrant, we know not how many years, but apparently increasing with age. The berries eaten from the tree have a pleasant, thorn-apple (*Cratægus*) flavor. They are parched by the Indians and eaten so, or ground and used as a kind of coffee, or thickened into mush, or made into bread, cake, or the like, when it has a peculiar nutty flavor. It blooms chiefly from June to August; yet here and there fine clusters of flowers may be found at any season of the year; the thickly-set laurel-like leaves extend close up to, and lesser ones in among the flowers; it fully ripens its great masses of bright red berries about merry Christmas, hence it is often called "Christmas Tree," and the fruit "Christmas Berries," in part from this coincidence; but mainly because of its universal devotion to those religious and rural adornments that will ever associate the concomitant Toyon Tree with all the innocent social festivities of that season, and of the "Happy New Year." Yet, withal, to the unbiased eye of art, and to the appreciative landscape gardener, the brilliant contrast, soothing warmth, and harmony of bright red on a background of green—ruby in emerald, and at such a season of the year, too—will always commend this Laurel Hawthorn as one of the chief ornamental charms of the coast. Even the faults of the formal and rigid become merits when they contribute to the Winter scene an air of calm, serious stillness, in peaceful keeping with the general hush of the Great Mother, while her large family is sleeping! Nor is this equanimity ever disturbed at seasons claiming less attention—the constant gales that deform the sturdiest oaks and other hardy trees and shrubs, pass harmlessly by the Laurel Hawthorn and the Satin-tassel trees, and but few besides, little, if at all, the worse for the fierce war waged on them during our wintry Summer winds.

The bark has a cherry or pleasant bitter almond flavor, and possesses similar medicinal virtues, which, indeed, would well nigh fill a volume to delineate in detail. The wood, especially the root, is highly ornamental, but has hitherto attracted little notice.

SATIN-TASSEL TREE.

(*Garrya elliptica.*)

"The mind—that ocean where each kind
Doth straight its own resemblance find."—*Marvel.*

A large evergreen shrub or tree; eight to fifteen or twenty feet high, three inches to a foot or more in diameter; the most notable for size lately grew near San Francisco, at the San Bruno Mountains, having five principal branches, each five to six inches in diameter from a short main body about one and a half feet in diameter—surpassing any oak trees of the vicinity. This tree, indeed, bears some casual resemblance to the Field Live Oak (*Q. agrifolia*); but the Satin-tassel tree has opposite entire leaves, *i. e.* without teeth, or lobes; on the contrary, most oaks have saw-teeth, frequently more or less deeply cleft or bayed leaves—always alternate; this has the twigs also somewhat four-angled. Of course, if the fruit of the female tree is observed, it is found in clusters of tiny little grapy bunches of purple bladdery-like berries, more or less silky, which stain your fingers purple on pinching them, even though dry and crispy-skinned outside—then to you, this tree is no longer doubtful; and as the fasicles of stiff tags—one to three inches long—fruits, or relics of some one remain on all the year round, they never lack a present manifest witness of their identity. The leaves of both male and female trees are alike elliptical, base rounded, mostly sharp pointed; margins wavy-bent, dark green and smooth above; whitish, with short wool beneath, one and a half to two inches long, about an inch or so broad; nevertheless many details must needs be omitted. So only, the aided and quickened eye of the observer, seize some relatively strong points that distinguish them and pass on. Confronted with the masculine tree, which promptly steps to the front rank of sylvan beauty, when in Winter or early Spring his partner's modesty makes but humble display; behold the long satiny tags, five to eight inches in length, pendant in parallel plumb lines on the tranquil air of calm days, or early dawn, like little lambs tails on the lawn; air of the honest, and the upright, e'en to the last jot; in perfect keeping with rectitude to the extremest frankness and candor of innocence; in a word, these tags, or catkins, are the most sensitive, softest, and most flexile satiny pearls, strung with living lines, ever hung on emerald mantle. From out the vast empyrean of love, significance to landscape art, to painter, or to poet, ruralist or sage, higher and highest, is ever begotten, ruled in wisdom, registered on all these—His works. To us, this Tassel Tree mingles with the rugged and sturdy, sober, and serious, somewhat of the pretty and the playful. Return with us again; view it astirred by the breeze; now, those long limsy tags in their rollicking giddy motions will surely remind you, in their perfect abandon, of those wanton lamb's tails—when the lambs themselves were wont to play "tag" on the sunny old barn floor of a gay Spring morn, in the days when you were young; or witness the like joyous lines and big successive drops leap out the cascade, arching airy diamonds aloft with an extra touch and toss of freedom, grace, and beauty, high above and beyond, ærating the choicest gems of the fountain; or have we in all serenity of delight seen the lambs cascading, tail and all, in a similar way? then tell us if they do not run together in parallel lines of a just similitude adown to the great ocean of truth.

The wood appears to be exceedingly hard and tough, but we have no knowledge of its applied use. As a tonic and febrifuge it is scarce at all inferior to Peruvian barks. Of the *Garryas* we have about half a dozen species, of which this is, perhaps, the best type. Ere long we trust they will be duly appreciated, for ornament, for medicine, and for other uses.

CALIFORNIA MYRTLE, OR SWEET-GALE TREE.

(*Myrica Californica.*)

"Sitting in a pleasant shade,
Which a grove of myrtles made."—*Bannerfield.*

A tree thirty to forty feet high, one to three feet in diameter; always a large shrub of ten to twenty feet, emulating trees. These dark evergreen, densely leafy shrubs or trees, are covered with balsamic glands that yield their sweet aroma to the breeze, and when bruised in the hand, emit a strong but refreshing resinous, or rather balsamic odor, as observed, that greatly reminds you of the Eastern little sweet-fern shrub (*Comptonia asplenifolia*), to which it is allied; to the European, however, it recalls the delightfully fragrant Sweet Gale (*Myrica Gale*), of his home beyond the waves; and, by the way, it should be noted that the true Sweet Gale is also a native of California, found in the cañons in the vicinity of Yosemite, where we collected it many years ago. These Myrtle leaves are rather narrow, one half inch or less, lance-shaped, about three inches long, somewhat saw-toothed on the margins, chiefly above, moderately wedged towards the base, alternate, and when young, of a bright, lively, yellowish-green tint, slightly varnished, the color nearly alike on both surfaces; this cheerful hue is very pleasing to the eye, seen against the darker background of the old and denser foliage itself. In all the earlier periods of growth, even well nigh unto old age, the habit is mainly more strict and erect than much spreading; bark, dark iron-hued, not very rough, often smoothish; aments or tags, very short and crowded, not conspicuous; the granular-surfaced berries of the size of peas, clusters situated along the twigs near the end of the previous year's growth, they are dark purple, staining the fingers on pressure; the very thin pellicle of wax is so obscure one is apt to overlook it altogether unless special attention is called to solve the question.

The largest Myrtle ever seen here, so far as I am aware, flourished in the heart of the City of San Francisco many years ago. This was renowned for its massive proportions, consisting of three large tree-like trunks, each about a foot in diameter, from a short base, or main body, nine feet in circumference. This grand sentinel stood guard by a spring on the eastern slope of Russian Hill, under whose shadows the early emigrant of '49 camped. Groves of them hid the marshes of the lower portions of the city, but they are gone, as perhaps most of their companions soon will be forever. So, also, along the banks of Lobos Creek, and elsewhere, it was no unusual sight to see trees one, to one and one half feet in diameter, and thirty-five to forty feet or more high, yet even these, which any tolerably enlightened self-interest would have preserved, a wanton water company cut away; nevertheless, we have an abiding faith that it will not always be so. Let us turn our eyes from the pit of our own and others' errors. Full oft the charm that fascinates, in communion with nature, is not the gay flower, the handsome leaf, nor any symmetry of form in outline, mass, or detail, nor grace of motion, waving with the wind, nor rustling in sympathy when astir and softly pillowed by the gentle zephyr; nay, but whatsoever hath paramount power to move most deeply the affections which underlie all the blandished arts and airs—and these are those sweet aromas that wake the soul to love. They come down anon with overwhelming power in our inspirations of ethereal Autumn airs, when all the landscape is brown and bare, when the cloud-curtain of the faded year is ready to drop on all that was beautiful and fair to view without, overshadowed the divinely human, transfigured, we feel that it is good to be there—are ready to pitch the tents of peace and dwell therein forever. But returning, are there not thousands of similar kindred mysteries to Myrtle odors in every one's personal experience, that commend them and their like to culture? or what else is it that hallows and charms our affections, but sweetness of spirit, and other mental quality within, that so blinds us to irregular forms and features of friends, objective or individual, with whom we hold such pleasant converse? Is it not the real soul, or something like it on the other side, beaming through? Or let us reconsider the ground of our esteem for numberless pets of the garden, field, and forest—true, one of a thousand may possibly be fairer to us than the rose or the lily, and altogether lovely; if so, we have indeed found at least one of the real trees of natural life, perchance of foliage, flowers, and fruits of honor; trees of renown, the planting of Jehovah, that He may be glorified, glorified in man, in that only paradise of the soul, wherein is found celestial joy and gladness and the voice of melody.

As these Myrtles abound in benzoic and tannic acids, resinous matters, and fragrant volatile oils, the bark and leaves are esteemed in the arts and for medicine. The wood is used as fuel.

WESTERN JUNIPER.

(*Juniperus occidentalis.*)

"And as Elijah lay and slept under a juniper tree, behold, then an angel touched him."
Ancient Book of Kings, Vol I: xix, 5.

The Western Juniper is one of the most venerable and picturesque trees of all the higher mountain regions of California—venerable as to appearance, and for the vast antiquity of the larger trees, which date far back, nearly to the Great Sequoian age; and picturesque, for often hundreds, nay, thousands of miles may be traversed without meeting a single perfect tree. All seem more or less dismanteled, or the top altogether carried away by storms or the ever-recurring snow-slides. When viewing these veterans, let us bear in mind they have braved the eventful cycles of time, that are measured by many thousands of years, with a vitality almost equal to the olive tree. If killed by any cause on one side, the other still goes on its life-long journey, eccentrically developing, until the investigator finds it convenient to take bearings in order to determine the original center. This broad base of accelerated expansion is always more or less unsymmetrical by those big bars of swelled or anguloid eccentricity so eminently characteristic. Above, it rapidly tapers to an attenuated top. Whole groves of the typical tree may be sometimes seen forty to fifty feet high, from a body eight to ten feet in diameter of the most perfectly free and unmolested development in relatively rich soil at the head of Carson River, or in a few of the most favorable cold alpine valleys.

The bark is of light cinnamon color; fibers somewhat shreddy, which beautifully interlace, and are nicely netted. The finely, as it were, braided cord-like twiglets are remarkably condensed or matted, thickening the final spray. Thus it well maintains the expression of rigorous vitality, altogether suited to the perilous regions it inhabits—that is, along rocky mountain sides, mostly in close contiguity to the line of perpetual snows; or for the California Sierras, say up to about ten thousand feet altitude. It has also a very extensive range of country from Pitt River to east of the Cascades, in Oregon, and throughout our high Sierras, and towards the Rocky Mountains, until it meets the Red Pencil Cedar, or Eastern Juniper (*J. Virginiana*), in the Zuñi Mountains of New Mexico, and even into Texas. The wood of this, however, is not so red inside, nor so fragrant, but lighter and yellowish; is equally durable, and of like value. The tiny leaf-scales are fringed on the margins (the Eastern leaf margins smooth), and branchlets four-angled; leaf-scales mostly in threes, often in pairs, blunt tipped or scarcely a little sharp, more resinous, and silvery sheened; in the young state the glands on the back are obscure; manifest enough in age. The blue-bloomed berries rather large, over a third of an inch in diameter, spheroidal, one or more seeded; the color beneath the bloom brownish, and sweeter tasted; when heated or burned, exhales a delightful aromatic incense, both exhilarating and highly salubrious. They also furnish boughs and twigs for a durable esculapian bed for the feeble pilgrim who is wise enough to spend a season of rejuvenation in the mountains and spread his primitive couch of them beside their all-glorious camp-fires. As these ecstatic aromas excite the affections and promote grateful perceptions, whence is all true adoration and blessedness, it is no wonder the prophet felt the angel touch him, an angel of health, if no other; nor that our sage ancesters burnt the Juniper around their dwellings to keep away evil spirits, or exorcise the demons of infection and every sort of plague, and held that an especially fortunate family, which was willing and well to do, withal so scrupulously neat as to strew faithfully their floors every Friday with some of these branches. We dare say along their devout footpaths arose some hallowed incense from the family altar.

Finally, if we view this tree securely sheltered from its manifold misfortunes that overtake it in its more exposed haunts, say in high mountain vales, or along the banks of those streams, it becomes a very handsome tree. One can scarcely realize the great contrast of elegance and beauty—perhaps, among a thousand expressions, the most general and striking is that stubborn air of death-grapple, and evermore irrepressible conflict of these veterans of a thousand wars, against all the combined elements of earth and heaven. Offset to this conic top of well defined, softly green, and graceful boughs and body, you still behold maintained the perfect symmetry of strength below. Or, yonder stands the usual type, a tree well nigh in ruins, perchance bygone greatness half in ruins, with modern repairs; or, it may be only a relic of passed glory, now lonely and neglected; here and there venerable and grave, anon grotesque, always in a high degree picturesque. But really who may tell all the varied expressions of this marvelous Great Far Western Juniper? They are more than can be numbered, nor may any artist ever cease to admire this inexhaustible sylvan study. They invite a volume of comment, we dare not enter the field, but wait with eyes afar over the landscape looking for the coming man.

To dwell upon its durable timber qualities, would be to repeat the lore of Cedar and Juniper renown; as live fences, rock and wall screens, naval knees, boats, common carpenter and cabinet work, and all uses where light, close-grained, soft, smooth, and compact wood is wanted.

CALIFORNIA JUNIPER.

(*Juniperus Californica.*)

" And she cast the boy under one of the shrubs"—of juniper.—*Moses,* Gen. XXI: 15.

This species is full oft only a large depressed shrub, or a small tree of twenty to thirty feet high; bark of body brown and shreddy; wood pale; outline of top irregular; branchlets thickest of any of the savin section; tiny scale leaves usually in threes; on young shoots they are loose and awl-form, white above; in age, they become short and thick, rounded at the tips, horny eye-lashed, or fringed on the margin. These least twigs present the usual appearance of finely corded sprays, least, larger, and largest; these last being more loose and scale like. In the male flowers the anther scales mostly in threes, eighteen to twenty-four, rhombic, scarcely acute; scales of the female tiny aments usually six, and spreading; the galbuloid berry globose or oval, five to six lines long, signs of scale tips, or mucros scarcely prominent; seeds one, or sometimes two, four to six lines long; shell very hard, thick, and smooth, shining brown above, with large bilobed whitish hilum.

We are apt to confound this common coast and island species with the Great Far Western Juniper (*J. occidentalis*). However, as Dr. Englemann observes, it is readily distinguished by the fruit, this having a dryer, sweetish, and not so resinous tasted berry, which is larger and reddish blue bloomy (instead of being smaller and bluish black, or rarely brown, as *occidentalis* is). Found in the vicinity of San Francisco, on the Oakland hills, Mount Tamalpais, and Mount Diablo, all along the coast range in general, and on the islands off the coast southward; also, said to be in the Sierras, and so on to Utah and Arizona.

Junipers readily clip to any pattern, and thus form the most substantial, perfect, and lasting screens, walls, mantels, or mats of verdure over the most arid, sterile, sandy, or rocky places, etc., whenever planted and trained over or against objects deemed desirable to conceal; there is in this, only a furtherance of the order of nature, and because all men and things together tend towards sympathy, and manifold harmony, orderly, or disorderly with their surroundings, therefore it is, when with the former, that our eye dwells with more pleasing satisfaction upon forms that do little or no violence to the order of nature. Who can fail to admire the responsive facility with which the minor species of juniper like this, thicken in, and apply themselves to that humble habit that, with a hint of training, they so readily take on, of shielding the rude and the rejected; laying the soft and soothing hand of natural beauty over the sharp and ragged rocks, lighting up the lonely and desolate places of the land; venerable in sacred classics for shielding the wild ass boy of the wilderness and archer of the desert; the bright leader in sciences and human rationals.

The universal use of these berries in beer and spirits, is already too well known. Hitherto there has been no call, to speak of, on this coast for such superior timber; but if ever a naval demand for knees, or short ship timbers should arise, no lack of resource will be likely to limit the supply.

LAWSON'S FRAGRANT CYPRESS.

(*Chamæcyparis Lawsoniana.*)

"In Autumn, when the sunlight crowns the cedar-covered hills,
Shadows lengthen in the valley—shadows ominous and still."

Spirited before you stands undoubtedly the handsomest of all our Cypress family, the graceful Oregon Cedar—Port Orford Cedar, otherwise known also as Ginger Pine of lumbermen—every form of it a curve or line of beauty. Behold in detail the little flat and fan-like sprays, every one of them laterally bent and gracefully curved, as the lesser waves curve on the great swell that rolls responsive over another sea of emerald; and the long leader bough that crowns the pinnacle of its glory, bending off at a right angle as it bows to the breeze the most graceful among the ever graceful ostrich-like plumes, as wavelets o'er waves are piled, climbing her ever verdant pyramid of foliage until lost in the clouds or merged far up in the blue; and, over all this, a softened sheen of almost invisible silvery gloss, lovely as an infant's or maiden's skin; indeed there is not a masculine, scarce a mere intellectual angular feature anywhere to be found about this charming tree. Granted space to spread freely in sunlight and air, the slender branches, although early ascending horizontal or depending with rising extremities, nevertheless the final boughs and ultimate sprays always hang down their modest heads—those below, nearly to the ground—and so maintain the ruling feminine expression at all points and at all stages of growth. Free, in the land of the free, she develops as all orderly things should, upon her own God-given type, a light columnoid conic-topped tree of refreshing symmetry; and no thanks to thee, oh barbarous scissors—the abomination of all the trees. When closed in and crowded by aggressive neighbors, the body is prudish and straight to a line often fifty to one hundred feet, with neither knot nor limb; in such cases trees often attain to one hundred and fifty to two hundred feet or more, with that elegant shaft four to eight feet in diameter. The timber is held in very high estimation for floors, blinds, and doors, finishing work, and for manifold purposes where clear, free, soft, and durable wood is requisite; is rich, very delicately cream-tinted, finishes uniformly smooth, like eastern white pine; for ceilings of rooms the aroma is found to be in a high degree sanitary; it has become the principal wood used for tubs, pails, etc., and is found excellent for boats and ships, for hollow wood-ware, when bound with brazen hoops, exceedingly neat and lasting. It should be observed, however, that it is to be avoided for most cabinet work, *i. e.* where delicate linen and the like are kept, on account of the volatile resin permeating and discoloring all such like goods, and that to such degree as to utterly ruin them; also, smooth and hard bodies condense it rapidly, and are soon all gummed over with dewy, and ever increasing dots, or rubied or wine-colored resin, that tarnishes to an intolerable nuisance, to say the least. For shingles, this with redwood and incense cedars, and the like, the State and coast has the amplest supply, besides that vast sylvan mine of the Great Sequoias.

A tree so choice for rural adornment requires a word of caution concerning its culture. Perhaps one of the greatest and most radical faults in the propagation of these and similar trees, is that of covering the seed with soil. In nature, they germinate on the surface, root down, and shoot up from that point, so that the pith is never below the moistened earth-level whence they spring, therefore they never sicken, sour, and in their agony, succor abnormally, become stinted and precocious, crippled from the cradle, but go on in the harmony and order of nature, prospering and to prosper. True, this is hidden to all but the intelligent eye until the charm of their youth is gone. A hint to the wise in passing must suffice. Having so often seen the ill effects of a contrary course, as duty demands we enter our protest against the profanity that ignores the sacred lessons inscribed on every page of the great Book of Nature. Easy would it be to point out the rationale on physiological grounds, but this must be left to the inquiry and intuitions of those whom it may most concern. There are many other important points of interest, best known to cultivators, that require to be observed in treating trees, especially those designed for a hardy endurance of severe climes.* This beautiful wintergreen conifer is found on the Coast and Sierra connecting ranges of mountains of Northern California, in the Shasta and Scott mountain ranges, only a few rarely straggling along south.

INCENSE CEDAR.

(*Libocedrus Decurrens.*)

> "Down in a vale, where lucid waters played,
> And mountain cedars stretched their downward shade."
> —*Sir Philip Sidney.*

This great Cedar of our coast and mountains is remarkable for its super-eminent use, beauty, precision, and aspiring grandeur. Devoted to the conic plan, few diverted limbs ever spread afar to mar the general purpose—elegant and upright in early life, it becomes at length grand and dignified with age; is also eminently noted for great rapidity of growth, wonderful lightness, stiffness, and extraordinary durability; in short, a thousand uses have sprung up, and are multiplying around this interesting Cedar as its most inestimable qualities become better known. Fortunately for us, it is one of the most extensively distributed trees of the Pacific—found from the coast range north, south to San Diego, Sierra Nevada, Southern Oregon, and most of the interior mountain region, from two thousand to four thousand feet, and even thrives quite well at six thousand six hundred feet altitude; and, so far as we have observed, seems to give out at seven thousand—said to extend to eight thousand five hundred (?). As usual with our sylva, flora, and fauna, this also is found lowest along the coast where it finds the requisite temperature, etc., with combined moisture. The base and lower trunk somewhat resembles the Western Juniper (*J. occidentalis*); it is to be noted in general that trees of such broad, outwardly sweeping, or expanded bases seldom blow over. and to the perceptive and artistic eye their significant expression is one of firmness and stability; one hundred to two hundred feet high, six to nine feet in diameter—rarely larger—the shaft often clear of limbs eighty to one hundred feet, and although the lower limbs, or even dry branches, may encumber the middle portion, pin-knots do not damage the timber. As the massive body tapers more rapidly above than redwood, and is less eccentric than Juniper, nevertheless its general port reminds one most of the best specimens of this latter; the light cinnamon-bark is thick, of shreddy-fibered texture, but so concretely compacted as to render the surface evenly ridged by very long, big bars of bark; these sweep obliquely down on the long spiral twist of swift water lines, which gives it the

* Naturally the lower limbs of trees subserve the fundamental use of accumulating base material for future prosperity and endurance, as bulbs do from former leaf-growth, storing up their early acquisitions as frugal deposits, in anticipation of final flowers and fruits of more mature age. This principle is even more manifest in Agaves and the like, which fail to thrive —never flower or fruit if deprived of their lower leaves.

expression of deep, determined currents, and adds to dignity, decision, and force of character. Top conic, the foliage, closely viewed, is in compressed, flattened sprays, aspiring and upright, thickened and somewhat succulent or luxuriously tender, if not languid type, at least in no sense rigid, nor thrillingly sensitive to the breeze, but concurrently moving in masses, bears some resemblance to the Great Western Arborvitæ (*Thuja Gigantea*), but these tiny leaf-scales are opposite and quite awl-pointed; besides the close-pressed, adherent base runs far down along the twigs below the free tips; general hue of the foliage light yellowish-green, or warm-tinted, beautifully golden bead-tipped, with tiny oblong male catkins, as the fruit ripens in October and November; cones pendulous from the tips of twigs, oblong, egg-form of six very unequal scales, two principal ones, or large pair, swelled on the back gradually below, pointed on the back just below the tip; intermediate pair much narrowed, a few bract-like, spine-tipped, short scales under the base; seeds oblong, like a grain of rye, two-winged, one wing developed to the size of the larger scales; the other is at its side, below, and much smaller; cone seldom over three quarters of an inch long, little more than one third as thick, and for the most part a trifle compressed; wood, pale cream-tinted in color, a delicate salmon shade. This would hardly warrant the name of White Cedar, sometimes applied to it, as well as to the Giant Arborvitæ. The extreme lightness of the lumber, and its sweetness for packing-boxes will commend it for express and commercial purposes, for posts and fencing, and especially railway ties, for sleepers, stringers, and ground timbers of all varieties, and for unnumbered uses, a tithe of which cannot be told in this brief notice. Formerly these trees were cut away and burned up to clear the track for redwood, tamarack, and ponderous pitch pines, etc.; now all else is superseded by this Incense Cedar. Thus we see how hasty and ill-advised notions give place to genuine merit.

A fungus (*Dædalus*) attacks and honeycombs it; and riddled as it may occasionally be, still if spike or nail find substance enough to hold, or sufficient solidity to resist crushing, then practically for many purposes, even such lumber is as good as the soundest timber; because, when the tree dies the fungus dies, and thenceforth will absorb no more moisture than the soundest part, and is alike imperishable, contrary to common experience in similar cases. This is another timber nearly as lasting as solid granite; hence we see how little reliance is to be placed upon ignorant assertions of transient visitors from abroad. For ship or boat lumber, the clear stuff, from sound wood, is so exceedingly light, stiff, and durable, and practically so abounds as to be available; few timbers on this or any other coast can excel it, unless we except the Yellow Cedar or Cypress (*Cupressus Nutkaensis*), which is a little tougher, stronger, perhaps more elastic, and equally durable, if one may be allowed to judge apart from thorough tests and careful data, which the apathy or ignorance of some Governments appear to deem unworthy their sublime attention. There are in California a thousand times more and better kinds of naval timbers on Government lands as important to preserve as the Live Oaks of the South Atlantic States. It would not in the least surprise me if, after due investigation, California would be found to possess a vast amount of the best naval timber in the world, and a hundredfold more lasting than the best now in use, if we except a few of which there is no adequate supply worth mentioning anywhere.

THE GREAT WASHINGTON CEDAR.*

(*Sequoia gigantea.*)

"If I will that he tarry 'till I come, what is that to thee?"—*The last of John.*

We cannot give a full history of this wonderful tree here, suffice to say, briefly, for in this we chiefly collate from Mr. J. Muir, who has best said, substantially: "The great *Sequoian* timber belt lies along the Sierras upon the first exposed mountain side," moraines of recent retiring glaciers that face the Pacific from Calaveras on the north, to near the head of Deer Creek on the south, a distance of two hundred miles, or little above thirty-eight degrees north to a little below thirty-six degrees; altitude, five to eight thousand, rarely eight thousand four hundred feet, broken by two gaps, each forty miles wide, caused by manifest topographical and glacial reasons given; one gap between Calaveras and Tuolumne, the other between Fresno and King's River; thence the vast forest trends south across the broad basins of Kaweah and Tule, a distance of seventy miles, on fresh moraine soil ground, from high mountain flanks by glaciers. The inscriptions (we have often examined with Mr. J. Muir) scarce at all marred by post-glacial agents, and the contiguous water-worn marks are often so slight in the rock-bound streams as to be measured by a few inches. Rarely does one of these sound and vigorous cedars fall, and if so, lie eight hundred to a thousand years, scarcely less perishable than the granite on which it grew. The great Sequoian ditches, dug at a blow by their fall, and the tree tumuli, always turned up beside the deep root-bowls, remain, *but not a vestige of one outside the present forests has yet presented itself*, hence the area has not been diminished during the last eight or ten thousand years, and probably not at all in post-glacial times; the notion, therefore, that this species tends towards extinction more than others, or the planet itself, seems absurd, for its vital vigor is assured in ages past and present, and, so far as mundane things can be, to come. These colossally sublime *Sequoias* rise two hundred and seventy-five, three hundred, and even four hundred feet aloft, are twenty to thirty, and in some rare cases, forty feet in diameter, like vast columnar pillars of the skies. No known trees of the world compare with them and their kin, the Redwoods, for the focused proximity of such a marvelous amount of timber within limited areas; as it were, the *ne plus ultra* standard of timber land capacity. Nor is language alone adequate to impress upon us any due realizing sense of such vast tree magnitude without comparative and associated statements, as if this were the all important idea, and truly the utilitarian is a good foundation, indeed enormous factor of some import; thus, the stage-coach passes through one; one hundred and twenty children and a piano crowd inside another; house for cotillion parties to dance "stout on stumps;" horse and rider travel afar within burnt out hollows of

* As historic truth demands, it is but just to say, I, myself, took Mr. Lobb to the California Academy of Sciences, and showed him the first specimens he ever saw of this marvelous, now world-renowned, Washington Cedar, which was so named by me, before he ever saw the tree. This fact is well known to the old charter members of the Academy, several of whom are still living; it is therefore the earliest among common names, and claims precedence, by all courtesy, in point of time, as also in appropriateness of honor. Our relations to its earliest identification we leave to the historian of the future.

others, and so on, with variations. A single tree would furnish two-rail fencing twenty to thirty miles, etc.

Having often visited these groves, a word may be allowed relative to their sylvan claims, apart from lumber and cordwood contemplations. Familiar as we all are with their ready growth into sturdy conic juvenile trees, with exceeding broad swoop of base, we pass to these of columnarly towering and spiry-topped youth of a few hundred years or so; then, at length, we behold face to face the Great Washington Cedar in its prime, to the grand and picturesque with the ages. To our view, their expression is one of softened and more lovely beauty with advancing years; vastness harmoniously merges into dignity and elegance, even in the most picturesque, with here and there huge arms thrust out towards the horizon round about; never exhibit the wayward vagrancy of many other trees, but so soon as they approach the appropriate outline of towering symmetry, swoop upwards in one grand triumphant air of sublime attitude, their bright and burning arms aloft, appealing to Jove's high throne in the heavens. The lesser and more massed branches accumulate above in ever-refreshing variety, in-sphering the upper body, and crowning the venerable domed head and massive brow in a halo of softer, serener glory. Fragments of special foliage in rounded or varied tufts and touches, tiny buttoned bouquets of beauty, as it were, pinned on gracefully here and there for effect, to foil herculean brawn—so in least as in largest, to fill and soothe the sense; the tiny, tender, slender, and delicate little sprigs e'en hiding the finishing hand that gives the final touch of the Great Artist, forcible reminder of the light gauzy texture lines of the finest figures of our earth-born artists; but these drawn by hallowed hands on the celestial canvas—pictures of inimitable grace and beauty graven on the blue tablet of the skies. But what should be said of that great behemoth-like hide of bright cinnamon-brown bark, in massive mantle folds one to two feet thick of lightly compacted shreddy fibres, darker on the shady side, or in youth and early prime tinted in royal purple, nay, crimson-fired in the lingering smiles of the western sun's adieu. Then behold it flowing into large deep water-line troughs, as it were, careering silently on a smooth bed adown the mountain height, until broadening and free they serenely glide into their great earthy sea.

The hue of young trees becomes of somewhat soft invisible sea-green or delicate bloomy tint, but when the venerable foliage ripens into its golden age of glory, becomes yellowish-green. From noting the foliage in a general way, if more closely inspected, the leaves are awl-pointed and boat-keeled on the back, lapping one over the other in a scale-like way, loosely, as it were, alternating or spirally in four rows, and so passing around the ultimate sprays. Flowers on the tips of twigs, tiny pollen ones globoid. When cone-bearing forests are in bloom, the gentle rolling breezes waft the golden or yellow-folded clouds of pollen everywhere among the trees, or in this genus and firs, lighter or spirited aloft, the pollen-clouds drift along high up over common tree tops; nor have firs any fruit save on their tip-tops. This sulphur-like dust is often carried by storms afar, and, precipitated by rains, marking margins of pools, foot-prints, and ruts of roads. Cones, egg-form, two by one and one half inches, thick shield scales, diamond-disked or obliquely trapezoidal, roughly puckered, the radiating wrinkles in-drawn by the quilted center-point, laterally transverse ridged, the concealed part broadly wedge-shape, strongly persisting; seeds, three to five to each scale, slightly oblong or subrhombic circuloid, being obliquely wing-margined; the middle body part narrowly wedge-like, often very short, pointed in the slightly notched end, which is apt to remind one of parsnip seed or the like.

Finally, in all due homage, do we accord to this Great First Born of the Forest, not only priority in time, but in degree of goodness as to quality, preëminence at nearly all points of view, and as to state—past, present, and to come—whether as to use, magnitude, dignity, elegance, or beauty, yielding the palm of our forests to *Sequoias*, for they are indeed the Great St. John Cedars that never grow old, are never decayed, nor ever diseased, and forever rallying in youthful vigor to repair their storm-lost crowns; never known to die a natural death—sylvan types of the immortals.

REDWOOD.

(*Sequoia sempervirens.*)

"For they sing to my heart,
And it sings to them evermore."
—*J. P. Lowell.*

Towering Redwood Trees, of most enormous proportions, sentineled our entrance of the Golden Gate in 1849. Alas! what wits it now to us whether they saw the vandals or the vandals them? Lofty landmarks, objects of intense interest, this great colossal and characteristic evergreen of the California coast! bold, nay awe-inspiring, grand and imposing, herculean pillars of the heavens, from out whose blue vault they looked abroad o'er land and sea, high above the hill-tops beyond the bay.

Of the same genus as the Giant Washington Cypress, of world-renowned fame, of nearly equal hight—two hundred to three hundred feet, fifteen to twenty feet in diameter (rarely more), and usually seventy-five to one hundred feet or more of clean trunk, only second to *Sequoia* of Sierra—attains to thousands of years of age, and what is even more marvelous, these monstrous stumps still maintain their vitality. Trees of all sizes and to the extremest age, when cut down forthwith shoot up unnumbered saplings of great vigor and exceeding rapidity of growth; continued repetition, at brief intervals, only can kill them. The numerous branches are small and very short; indeed, relative to the size of the trunk, in age, quite insignificant; as it were, mere appendages. So intently devoted are they to the all absorbing timber-producing purpose of their great sylvan colossus, this enables them to close their ranks and crowd the land with an immense amount of timber per acre, absolutely unparalleled.

Occasionally, when a social circle of these young saplings spring from the parent root, say within the usual area of fifteen to thirty feet or so, renewing their youth in such close proximity, two or more may unite to form one large tree. Dr. Wm. P. Gibbons, J. Muir, myself, and others, have often seen the forested Philemon and Beaucis in lasting embrace, typically transmigrated, beneficent and happy still. Redwood foliage is like yew: the same flat and final starry spray or twiglets of small leaves, say one half to one inch long, distinctly in two rows, flat, line-like, with a sharp point, dark green above though not so shiningly varnished; underside soft grayish sea-green; tipped with young Spring growth of bright vivid yellow-green, then for beauty, they far surpass the gayest flowers and the prettiest ferns. More or less mixed with the common foliage, are leaves reduced to scales; indeed, some trees are found in every grove with awl-pointed, scaly leaves, like the foliage of the Great Sequoia; but among the Redwoods these are exceptional and somewhat rare. The garland-like limbs are chiefly spreading, save in great age or tipped and drooping with male flowers like the Mammoth King, or pending tiny terminal cones of an oblong shape, one to one and one fourth inches long and one half to three fourths of an inch thick, consisting of numerous trapezoidal disked scales, thickly and roughly implaited by the indrawn or quilted-like center; its very sharp prickly point turned forwards or pressed down and looking outwards; the shield-like disk more or less distinctly marked by a sharp laterally transverse ridge, stem of the scale stout, persisting, compressed, broadly-wedged form with some sharp angles, covered and stained by a dark purple, almost black, shining, fragile, and granular secretion, like gum Catechu, common to both species. Seeds, three to five to each scale, flat, oval, or obovate in outline, lateral wings very narrow or slightly and often obliquely margined, color dark reddish-brown, only a little notched at the outer and larger end, and shaped like parsnip or other similar seeds.

Redwoods abound chiefly, if not entirely, on sandstone soil—light, loose, black, or ashy—and always in the track, and confined to the fog limits of the coast, say fifteen to thirty miles inland, and probably never exceed forty or fifty miles, even in the most favorable low coast ranges where the fog passes over low lands or through open gaps. These mighty majestic redwood wands possess a magic power over passing fogs, wontedly precipitating them in showers of rain at their feet—for this, mainly, among many other good reasons, living springs of the purest water ever bubble and babble at their bidding—choice guards, as they undoubtedly are, stationed around springs and water supplies, they are, for this very reason, all the poorer roadside or more intimate rural companions. The continual timber supply capacity of a redwood forest, under judicious care, is so prodigous as to be simply incalculable; none but a suicidal and utterly abandoned infanticidal policy, wantonly and untiringly practiced, can ever blot them out.

The timber is red, with a faint coppery or metallic iridescent gloss. Choice curl-grained wood is very ornamental for cabinet finishing and similar work—takes a fine polish, simply stained or varnished, it is far preferable to any paint; the hues deepen to richer darker shades with age. Well matured heart-wood of the base of these trees is so solid and heavy as to sink in water, *i. e.* for a few saw-log "first cuts," as the log-men express it; these will last for ages, under the most trying circumstances, like cedars and yews. The upper part of the same tree, on the contrary, is soft, exceedingly light, though of like fine grain, only more brittle, but insects seem never to trouble any of it. It is a great, and certainly too common error, to choose timber by name rather than by selecting the proper quality. During our earthquake experiences we had occasion to examine many walls, all alike laid upon redwood plank, in the lower made portion of the San Francisco city front. Some foundations, of just the same age, were apparently nearly as perishable as poplar, while others were as solid as so much cypress or cedar. Seasoning alone, important as that is, like age for wine, will never make the originally poor good.

Probably, from a fair estimate of the redwood forests along our coast, it would not comprise much more than about three thousand square miles of timbered land. The already extinct and too scattered portions are ignored in this estimate. This Coast Range timber belt extends from the northern portion of the State south to San Luis Obispo. Access to tide water, great economic value, and universal use, have, altogether, doomed these mammoth cedars to a speedy destruction.

The bark, reduced to bast, has been utilized for upholstering—an excellent material. The woodman covers his corduroy swamp passes and bridges with this very superior and imperishable material.

FRINGE-CONE SILVER FIR.

(*Abies* [*Picca*] *bracteata.*]

" The groves were God's first temples."—*Bryant.*

This exceedingly elegant steeple-shaped Fringe-Cone Fir is of the most extraordinary aspiring beauty, and quite unlike any other silver fir of the Pacific. The general outline approaches that of the White Spruce (*Picea* [*Abies*] *alba*) in its best types, simulating the form but not the habit of the Lombardy poplar, for the short limbs of this merely strictly shaped tree are not upright, as in that—the Oriental Cypress (*C. Sempervirens*) and Irish Yew (*Var. fastigiata* of *T. baccata*)—but the lower branches, from horizontal at least, are often bent back in the usual typical tented style of the spiry spruces; although the limbs above the middle and near the summit are mostly horizontal or spreading, and very slender, yet exceedingly tough and reliable even when long dead—arranged in whirls; but there is scarcely strength in the main leader body of the very tender long attenuated top to make it at all safe to climb to the cones, which, as in all the firs, sit upright, like birds upon the branches; and if neither apparently, with figure and metaphor, nor actually fringed with a crown of gold, yet the fruit is worth many times its weight in gold, so exceedingly scarce and valuable is it esteemed.

This invaluable, rare, and hitherto little known fir, rises from one to two hundred feet high, and from two to four feet in diameter; trunk as trim and straight as an arrow, but full of knots that extend well to the center; branching so low, it furnishes little or no proper lumber, but is a perfect pattern of sylvan perfection on the symmetrical plan. Arctic or Alpine trees of this extremely attenuated type—the slender parts are frequently broken in outline by the severity of their clime, and hence exhibit more variety, often bordering upon the fantastic—but these are so sheltered by the deep gorges in which they grow, and being so thickly branched below, as well as throughout, and clad in a light green dress of silvery sheened foliage nearly or quite to the feet, gives them the most exquisitely delicate and elegantly feminine expression it is possible to conceive. Besides the modest plumy-fringed cones, evanishing up in the blue amid a kind of gossamery webby haze, is eminently pleasing; the foliage is gemmed with golden drops of gum, that glitter in the sunlight like radiant beaded jewels, thus sparkling all over, from crown to foot, with gold and dewy diamonds. contribute no little to effective beauty and to more oriental ornamentation of this fringe fir. According to our taste, this is the loveliest of California's silver firs—most ornamental, most valuable—but it is only a half-hardy tree, not well suited to great extremes of temperature nor exposure to violent winds. So far as we know, this fir is only found on the Santa Lucia Mountains, latitude thirty-six of Southern California, altitude from four to six thousand feet.

Not being likely to confound this fir with any other, our excuse for a brief specific note, is its rarity: Buds large and pointed, leaves from two to three inches long, line-like, entire, flat, rigid, sharp pointed, varnished green, and no breathing pores above; one half twisted at the base and in two rows; two silvery gray lines below, cones egg-shaped, four inches long by two to two and one half inches thick; scales smooth unlike any other fir, roundish kidney form, the narrow wedge-like claws short, falls off tardily from the fixed axis, the hidden part of the protruding bract, wedged, rigid, leathery, three-toothed at the top and these teeth again finely subtoothed, whole form short and roundish; the straw-like mid-ribs stick far out from between the scales from one to one and one half inches, and spreading or gently recurving they loosely fringe the whole surface of the cone and are beaded with turpentine; seeds oblong, wedge-shaped, four sided, skin light leaden gray, wings slightly obversely egg-form, of membrane-like texture, entire, flat, and thin.

THE GRAND SILVER FIR.

(*Abies* [*Picea*] *grandis.*)

" Rose the firs with cones (like birds) upon them."—*Longfellow.*

The perfect elegance of this trim lofty silver fir is greatly enhanced by the relatively small diameter of the body. A tree may be from two to three hundred feet high and the trunk barely four to eight feet in diameter, with a marvelously clean shaft from eighty to one hundred, or even one hundred and forty to one hundred and fifty feet, as even and true as if laid off by line. The firs of this vicinity, say on the coast within one hundred miles or so of San Francisco, average one hundred and sixty feet high by two to three feet in diameter, although a few reach two hundred, by six to eight feet through. The distance to the first branches, thence towering to the at length conic or flat top, seems much greater than it actually is, since they scarcely approximate what we are accustomed to consider colossal, but rather the columnar type. These lofty columnar and towering traits of Pacific trees are more characteristic of these far western forests than of the same species under culture. This fir is sometimes of singularly slow growth, in its early state, as are also some of the spruces, and again other trees increase rapidly from the very first start up to maturity, which, for the coast here, is between one and two hundred years—after one hundred and fifty to one hundred and seventy-five years the growth is barely nominal. As an example of the former early, nearly tacit *statu quo* state, say for forty years, the rate of increase may not be even one quarter of an inch in ten years for the whole period or more, if much stinted in the start. Of the latter the rate is exactly reversed, the rate of increase then being one and one half to three inches in every ten years for the first forty years, and the exceedingly fine decadent annual rings, instead of being at the heart as before, are seen next to the bark. This rate is to be esteemed as very variable, for some of these firs, at their most southern limit on the coast, will even occasionally make one inch thick of annual ring-growth. In thus laying down these extremes of illustrative variation, we are cautioned lest we generalize on too scanty data or too limited observation; nevertheless, we feel warranted in saying that, as a general rule, firs are of rapid growth—and allowing that they may live a few hundred years—yet they are what we should designate as short-lived trees.

The branches of the Grand Silver Fir of the coast here never pend, but maintain a perfectly horizontal position, in age the top becoming reluctantly squared or flat topped. The bark grayish-brown, rather thin, two inches or so for trees three to six feet through, brittle, and not much roughened; the silvered foliage deepening to dark green towards the top, and at the crown quite dark hued. The leaves, as Dr. Englemann observes, are glossy green above and without stomatæ; two well marked white bands below, each consisting of seven to ten rows under a strong glass, one to two inches long, more markedly distichous (two rowed, one on this side and the other on that, or opposite sides of the twigs), at least in the sterile branchlets, than most other silver firs; strongly grooved and the end notched, leaves on the fertile branchlets similar but rather shorter, and occasionally rounded at the tip; leaf-scars rounded or circular, not elevated. The cones, as usual in firs, on the topmost boughs of the tree, set upright, like birds upon the branches; cylindroid, three to four and one half inches long (seldom longer), about one and one half in diameter, obtuse, often with short titted center, from the somewhat more depressed or retracted surrounding, and still rarer abruptly acute, when broken off the based portion, like *A. Concolor* (?), deeply cupped by the much bent scales and seeds, dull velvety greenish or parrot-bronze tinge; scales one quarter broader than long, the outer air margin of the segment of a rather smaller circle than its very close kin, *Concolor* (perhaps only a variety); bracts under each scale short and included, or hid in the cone; this is oblong, obcordate, finely cut-toothed on the end and sides, mostly the central sinus or notch with a rather long lance-pointed mucro; this thin appendage beneath scales, it will be noticed, is narrowed below or wedge-shaped; seeds with an American ax-like wing, about as broad as long, ripening in November, or farther north a month earlier. The wood is white and soft, when well seasoned makes the best of stiff strong girths, etc.; holds nails remarkably well; makes good inside work when protected from the weather, but is very perishable when exposed. It is held, however, in little repute by lumbermen as yet. This is the white fir of Oregon—from beyond the Cascades of the Columbia River to the Pacific Ocean, and from Frazer's River to Vancouver Island.

Trees felled and left in contact with the earth, and so exposed to the seasons, will utterly perish so as to be stamped to powder under the heel of one's boot, in five or six years. At its southern limits it seldom fruits, and the few cones found seldom or never produce good seed.

A lofty tree, most aptly named for its most superb grandeur and beauty, worthy of all care and culture, the finished columnar shaft losing its slender lower limbs, for lack of light and air, very early in the native forest; rising almost palm-like in its exaltation, crowned with short cone, or flattish like the pine or quite as the cedars of Lebanon, but with no great spread, and elegant smoothish or fissures shallow and openly spread, and thin, iron-gray bark, silver-lined foliage; fruit, as it were, brazen plumaged birds perched upon the topmost boughs, and you have a sylvan object of ever increasing delight to the beholder. The sapwood is about in the ratio of one ninth the diameter, and requires from thirty to fifty years to ripen into heart-wood, with due allowance for variability of growth.

In describing trees, some allowance must be made for what is called the "habitat," etc. A few general remarks may be allowed in this connection, to illustrate this principle: Take, as an example, the leaves. Now suppose an author to say of them, "more markedly two-rowed." To test the absolute value of this and similar manifest usual characteristics, upon which we are apt to rely, let us choose a similar case, unquestioned, as a standard of comparison. Let that be the Pacific Hemlock Spruce (*Tsuga* [*Abies*] *Mertensiana*), which also grows in the same localities as the above *grandis*, both at their hotter southern limits, say one hundred miles north of San Francisco. Here both become more distinctly, nay, strictly, two-rowed (distichous). This Merten's Spruce or Western Pacific Hemlock, north to British Columbia, has densely crowded leaves distributed more or less all around the twiglets, and the leaves are therefore exceedingly dense *there*, yet it becomes *here* perfectly two-rowed, shorter, and sparser, etc.—is, indeed, the airiest and gauziest of all gauzy trees ever seen. As with spruce, so with fir—*grandis* thickens towards the colder coast and mountains north—hence the variety *densifolia;* but if this is deemed a good variety because denser foliaged, then, by parity of reasoning, from similar local characteristics, we must also have a variety of Pacific hemlock spruce, and also varieties of varieties, and so on to the end of the chapter.

As qualities of timber, etc., sometimes also follow these diversified forms, it may be useful to designate many varieties, as woodmen and workmen are in the habit of doing, for their own convenience and use; and, as science has the same end, so, at length, also scientifically refined discriminations ever keep pace with the most thorough knowledge, and are useful so long as they do not transcend the practicable.

GREAT WHITE SILVER FIR.

(*Abies* [*Picea*] *concolor*.)

"Here spiry firs extend their lengthened ranks—
There violets blossom on the sunny banks."—*Fawkes*.

Among the most stately, elegant, and useful firs of the Pacific, with respect to all points of estimation, certainly none excel the white fir of the mountains. The cheerful contrast of light bark of body and limbs, as the eye catches glimpses of them here and there from beneath the soft starry mantle of living green, recalls virgin linen, white and clean, gleaming aloft from out the exalted spires of "God's first temples"—the primeval groves.

In its young state, this fir is half-spire form, the whirled branches spreading horizontally as do branchlets and final sprays, forming flattened fan-like distributions; the line-like leaves in two regular rows, one on this side and the other that of the twigs, as it were, winged; the pinnæ leaves usually notched at the end, two to two and one half and sometimes three inches long, indeed longer than any other Pacific fir. Rather gray-green, stomata-breathing pores, confined to the middle line but never absent; in older trees the lower limbs only have notched leaves—this last feature, however, is not specific and peculiar if more common; higher, they are then shorter, broader, rounded above, ends blunt or very short, sharpened; on flowering and fruiting branchlets they even become keeled above and almost quadrangular—stomata cover the entire upper surface, and they are not then so strictly two-rowed.

The White Silver Fir is a tree from two to three hundred feet high, usually four to eight feet in diameter, often with a neat naked shaft from fifty to one hundred feet or more; top always more pyramidal even in age than the great magnificent Red Fir (*A.* [*Picea*] *magnifica*), probably only another form of *nobilis*, with its colossal dark cinnamon-red body or bark. Found in the California sierras up to seven thousand feet altitude; the most eminently prosperous belt of the best timber lies between four thousand and four thousand five hundred feet of western and northwestern exposures (for present purposes we omit its Rocky Mountain, New Mexico, and Utah ranges east, or Oregon); at least here the timber is never as good above or below the above mentioned limits, nor, if lacking in any one of the best suited conditions—all of which we do not pretend to notice—as average temperature, rainfall, and the like.

Messrs. Towle Brothers, of Dutch Flat, have tried stringers for horse-tramways, three by six inches—half in earth, half in air, the alternate wet and dry test—some of spruce, sugarpine, yellow or heavy pine, redwood, and white fir, among these, all tried in the same locality and at the same time, this White Silver Fir outlasted them all. We examined these, and were it not manifest from many experiments, we should hardly have anticipated it superior to our Pitch Pine (*P. Ponderosa*). Dr. Parry informs me that a like reputation holds good, in that where it is preferred for railroad ties, etc. This fir does not warp like spruce, red fir, or Jeffrey's Owen's Valley variety of *P. Ponderosa*, with their marvelous efforts to get away from fences, etc. It makes choice ceilings, shrinks least of all, and takes less paint than any other lumber, as it abounds in (tannic?) acid. Spikes and nails never loosen in the lumber as in other timbers, so that as entire or half-earth sleepers, outside or inside work, it may be well commended. Another point, it should be remarked is, that the wood is not too hard to work, but soft in the region named, nor is the grain unsightly and coarse like spruce; besides, it is famous as the stiffest, strongest mountain timber, both for transverse horizontal strain and crushing perpendicular pressure, hence its far-famed esteem in mines, for bridges, and for strong floors; for butter barrels, kegs, and boxes it is superior, as no taste or odor is communicated to the contents, besides staves for laths and the like; but for laths, Douglas and Merten's spruces are preferred.

Where so much confusion has hitherto existed as to species, one must expect somewhat particular details—perhaps unavoidably prozy—had not the quality, also, been so egregiously decried, like other timbers of the Pacific, a word of commendation might have been sufficient for passing estimation and briefer notes, that only seize some strong points of obvious and ready recognition.

Cones erect or perched upright upon the top branches, three to five inches long and one and one half inches or so in diameter, usually obtuse, clothed in a very close soft yellowish-green or velvety scum-greenish mantle of exceedingly short villi scales; separately examined, edgewise or side-viewed, the claw is bent at an obtuse angle so that the cone, when broken, the base portion presents a deep cup-like cavity or fracture; these scales very broad in proportion, appendages or bracts beneath short, slightly wedge-like, rounded, blunt, or sometimes notched at the end, a sharp point from the center, wing of the seed broad American ax-shaped, or often as wide as long, if not wider, and so on. The most obvious marks are the ashy-gray body below in age, and always the white color of the body and branchlets above; the foliage pale blooming or of light gray-green tint.

THE NOBLE SILVER FIR.

(*Abies* [*Picea*] *nobilis.*)

AND ITS MAGNIFICENT VARIETY: *A. MAGNIFICA.*

> "When the bright sunset fills
> The silver woods with light."—*Longfellow.*

Among the most stately trees of the world stands the Noble Silver Fir of the far west—one of the truest types of nature's noblemen—towered and terraced to the skies, aloft on the high mountains from six to eight thousand feet altitude, or more; attaining from two to three hundred feet in hight and five to ten feet in diameter; bark of the grand trunk dark cinnamon-red or burnt carmine color.

> "Abroad their fan-like branches grew,
> And, where the sunshine darted through,
> Spread a vapor soft and blue,
> In long and sloping lines."

Thickly mantled in light and ever-living green, softly silver-lined, the grand horizoned round-tables of velvety verdure, rising series above series, the branches only lessening their ample area near the summit, strikes the eye of the stranger with amazement at the marvelous majestic port and perfect elegance of symmetrical beauty. To the appreciative eye, this noble fir is instinct with the air of magnanimity and frankness, suggestive of the bluntness of honest candor and altogether expressive of natural good nature, as we sometimes see where truth springs from a generous ground of good, with manifest laudable purpose. Its language, indeed, is manifold: listening with ears, seeing with eyes, or singing as every bird sings, as the proverb saith, according to its own bill, one may at least earnestly commend this noble sylvan glory to the high consideration and enthusiastic praise of the choicer songs, for none can ever cease to admire the Noble Silver Fir.

Our detailed notice of this typical tree will be brief, in view of a fuller description of the more common variety of *Magnifica*. From Mount Shasta south, along the Sierras to King's River, we have seen and collected specimens of the cones, with protruding bracts; indeed, in some places they appear to be the rule, in others exceptions, but these cones were only very imperfectly covered—unlike the *nobilis* sketched and painted for Dr. Newberry. (See Vol. VI U. S. R. R. Reps., page 50.) There are many points of contrast and comparison of more interest to the scientific than to the general reader.

The leaves of the fertile branches are shorter, flat-quadrangular, thickness not more than one half or nearly two thirds the width, upwardly curved but not twisted, thickly set close all round. Cones set, like birds upright, upon the very short top branches, five to six inches long or high (or even more), two to three inches in diameter, usually cylindroid-ovate, nearly mantled by protruding bracts, bent back and so thickly set and closely pressed as often to nearly hide the scales; the outer part broad, rounded, or heart-form; end either fringed or cut-toothed, the middle awl-shaped, point elongated. These tonguey bracts or scaly appendages, it is claimed, never become shorter than the proper cone scales, or so as to be hid from outside view. Seeds oblong or rather obliquely subtrianguloid, base wedge-form, pale shining or clayey hue, like the wings, cotyledons seven or eight. This great Red Silver Fir, of Northern California, forms large forests about the base of Mount Shasta, at from six to eight thousand feet altitude, and said to extend north through the Cascade Mountains to the Columbia.

MAGNIFICENT RED SILVER FIR.

(*Abies* [*Picea*] *nobilis var. Magnifica.*)

"The fir grove murmurs with a sea-like sound."—*W.*

This most magnificent cinnamon-bark silver fir of the Sierras—their valleys or inter-vales, steppes, meadow margins, or contiguous to cliffs of the ragged rocks—is by far the largest and most stately of all the firs. Found at an altitude of seven thousand to a little above nine thousand feet; attains from two to three hundred feet in height, ten to twelve feet in diameter, and is even reported fourteen feet. In its glory we behold the massive towery and somewhat rounded or domed *sequoian* summit; indeed its general port is even of more densely thickened outline than those giants of our Alps. The mass of this foliage is made up of formal, well defined, round table-like terraces, as in the typical *nobilis;* like branching, more or less in successive flights to the top, yet sufficiently broken, here and there, to preserve variety and still suggestively hold the mind to ideal order, dignity, and grandeur, the most imposing, the most magnificent. These innumerable segments of circles, silver-lined and baized above, that deeply naps the ample folds of this broad mantle of sylvan magnificence, are but multiplied lines of regal beauty, perfection, and symmetry. The earlier state of growth does not greatly vary from that of age, but rather foreshadows it; the form then is one of perfect regularity, on the precise conical plan, from a broad base by lessening turreted series of branches, whirling aloft to the conic or at length sub-conic top, tipped by a strong straight rigid leader shoot of vigorous growth. Perhaps this would prove too formal for the eye to dwell upon alone, but in nature they are never alone, nor in forests of their own. This strict outline is more bold, viewed in midday among the mountains. It then and there stands in striking relief against the usual rugged background of rocks and awe-inspiring alpine cliffs, and seems more harmoniously combined, complemented, and in due keeping with high mountain scenery. Yet, as a single object or within a restricted circle, it is much more softened and silvered from beneath by the nightly camp-fire, or when naturally crimson-fired by rising and setting suns. When thus aglow, diversified by other sylvan surroundings, the picture is one of surpassingly softened beauty—fascinating quite beyond description; the very warm glowing bark of body and boughs, always lovely, now more radiantly reflective than ever, reminds us of that other "fir tree set in the desert of the deserted"—sacred emblem of perceptive scientific truth of a superior order. As the wind-waves leave their own beautiful rippling records on the highland sands, so do the water-waves theirs along the shore; they also sing a similar song, the emblematic significance of which is nearly alike the same, for saith not the poet truly?

"The fir grove murmurs with a sea-like sound."

Hence it is that hearts nicely attuned to nature's harmony in the great forestal variety, full oft catch the grand orchestral chant that swells sublime in the mountain heights or sweetly dies along the gale, and even the tacit echoes from some far off song, perchance, comes softly swelling on the listening ear when a still small voice of silence is all about—above, below—and not a leaf astir among the boughs.

As for the serener haunts of the hermit mountain bird and the merry pine squirrel, the fir trees are their house—a velvety bed and board forever spread in silvered emerald. The beams of these temples are as the goodly cedars, and their rafters of fir, decked in gold and royal purple pillars, as it were, of the heaven's tent and table, silver-lined, balsam-perfumed, their airs are pure and sweet as the breath of lilies. Lordly shadows and secure shelters are they, where the weary pilgrim is wont to rest or repose in Eden sleep, on a virgin bed of boughs.

Dr. Englemann remarks: "Leaves of the young tree flat, scarcely grooved, never, I believe, notched; fibrous bundles in twos. On full grown trees, and especially on fertile branches, the leaves are one fourth wider than thick, or even perfectly square; the resin-ducts in these leaves, placed equidistant from the edges and keel, separated from the epidermis by a layer of hypoderm cells, externally indicated by a green stripe dividing the bands of stomata, so that these leaves show four lower white bands. Cones six to eight inches long, two and one half to three and one quarter thick, purple; bracts lanceolate, shorter than the broad scale, wing of the slender seed very oblique, wider than long; the only seed examined had ten cotyledons." The scales flat and set horizontally or not bent, so as to cup the cone.

The texture of the timber apparently like cedar—darker heart; makes excellent firewood; has been accredited valuable by some writers, but we have no personal experience or observation of its applied utility; said to have been extensively used in some localities, but from our observation of fallen trees in the forest it seems to us liable to speedy decay when left exposed to the weather.

PACIFIC SILVER SPRUCE.

(*Tsuga Pattoniana* [*Abies Williamsonii*].)

"Far off, indistinct, as of wave, or wind in the forest."—*L.*

The Silver Spruce,* as its common name *par excellence* suggests, is by far the most cheerily silvery of all the conifers of the Pacific. The early growth of this species, as seen in the high sierras, say from seven thousand five hundred to ten thousand feet altitude in California, or six thousand feet in Oregon, is elegantly spiry, branching broadest from the base, often in a decumbently ascending direction, at length outwardly pending tips, and so tapering aloft to the plumy top. The crowded wealth of fasiculoid foliage waves and surges the spray with such wonderful variety that its outline reflects the silvery lights and shadows to the greatest possible advantage. The weight of wintry snows often gracefully curve the base adown the steeps where they cling, thence righting up their recoil, the top compensates by an opposite curve thus gracing this impress of an early life-struggle for existence by another charm—a crowning wreath on the brow of victory.

The middle sized cones are perfectly symmetrical and smooth, subelliptically cylindroid, from two to three inches long, about three

* The name "spruce," as contradistinguished from "fir," in common parlance, implies that the cones pend gracefully down from the tips of the twigs and are distributed over all parts of the tree instead of the top only; and that the scales and their appendages persistently hold together and fall off at once, when ripe, like many pine cones; also, that when the flat two-sided and two-rowed leaves fall off they leave the sharp woody-like base or foot stalk prominent, and no spirally arranged bark-scars as in firs and pines; and as the cones do not stand upright, like birds upon the upper boughs, near the top, and fall to pieces at maturity, of course they leave no naked spindle-shaped woody axis still perched on the place where they grew as the firs do, and the bark never blisters in spruces. In thus defining these common names, as they are and should be used by us, only a few strong points of contrast can be wisely noted—others more technical are intentionally omitted.

quarters of an inch broad, purple and softly bloom-tinted, they tip singly or in clusters the slender twigs; thus bowing to their weighty burden, they strike you as exquisitely ornamental. These slender branchlets are pubescent, leaves from one half to an inch long, convex or keeled, *i. e.* angled above, rather sharp pointed, narrowed at base and curved, stomatoes on both sides; male flowers about two lines long, on slender thready stems; pollen grains bilobed, blooming in September and October; seeds two and one half lines long, wing about one quarter of an inch, or less than twice the seed, obliquely obovate and widest above. Many of these trees in the closer forests are tall and slender, from seventy-five to one hundred feet or more in hight, often irregularly branched, but they are always graceful and never formal. On open borders, with greater freedom for development, they are both grand and graceful—the finest of all the spruces. The sturdy, elegant trunk, of rather even reddish-brown bark, reminds one of the sugar pine; column often clean from fifty to one hundred feet, and six to eight feet or more in diameter, thence above branching into a broadened conic top, duly balanced to lines of beauty up to one hundred and fifty or even two hundred feet. The best types we have witnessed are at the summit of the Sierra Nevada Mountains, which certainly seemed, to our enchanted view, as though they must be, for their style of beauty, equal to any spruce in the known world.

The special form and analytic illustrative figures in Vol. VI of the U. S. R. R. Reports, are our own paintings. That portion, however, showing the reflexed condition of the scales is superadded to the original drawing and is not characteristic. This condition of old cast off cones, exposed to a burning sun, is also common to other conifers, and is eminently conspicuous in the cones of the Western Mountain Weymouth Pine (*P. Monticola*), etc.—we simply note the fact in passing. Typically, this tree is pyramidal, one hundred to one hundred and fifty feet high and from two to four feet through; but in high altitudes of California, say eight thousand to ten thousand feet, is often only a shrub. In the north latitude of the Cascades to near Crescent City, it comes down almost to the coast in due form.

DOUGLAS SPRUCE.

(*Pseudo-Tsuga* [*Abies*] *Douglassi.*)

"There is a quiet spirit in these woods."—*Longfellow.*

Douglas Spruce is found in great abundance in California and Oregon—from coast to Rocky, Blue, and Sierra Mountains—but does not climb the higher and highest elevations, yet ranks among the grandest of the lofty and exceedingly beautiful trees of the Pacific. This is one of the first and best known trees of the far West; discovered by Menzies, at Nootka Sound in 1797, during the voyage of Vancouver, afterwards by Douglas and truly identified, and in whose honor it received its final specific name. It has been well described and renamed by many authors up to the recent date of the last publication. This tree constitutes a large portion of the heavily wooded timber lands of the coast and lower sierra. A short time ago, on the

Central Pacific Railroad, about three thousand feet altitude, were to be seen specimens about two hundred feet high, nine to ten feet in diameter, and some, fifteen feet. In closely crowded forests they are even higher, reaching three hundred feet. Here the trunk often forms a column straight as an arrow, with scarcely a branch for from one hundred to two hundred feet. Like most trees of dense forests, our conifers are colonaded and towered, so that it is rare to find trees spreading, or even well spired continuously from base to summit, as seen under cultivation. We notice, however, on the most broken coast, those species of spruces and firs that climb the tallest steeps suited to their habit, and are, least of all, liable to be shut off from abounding sunlight and air, are those that retain their branches long; a few such sentinels, outskirting the crowded plateau-forests, also, are found of exceeding great beauty; the branches from horizontal at length droop in graceful curves with ascending star-spangled sprays, and these in softened slightly silvery tips joyously upturned, like the bent bow on its back, wooing the hand of some primitive Nimrod; thus, in due order, multiplying and successively aspiring, feathery, and flossily thickened in with foliage of unwonted delicacy, and grace inimitable. And again, where we see them thriving luxuriously upon moderate mountain elevations of free outlook, favoring soil, sun, and ærial conditions most conducive—as upon the lower mountain ranges contiguous to the base of Mount Shasta—its intrinsic native grace is greatly heightened to one's beau ideal of princely elegance and beauty. Witness those most extraordinary streamer sprays, seventeen to eighteen feet long, of similar slender size of plumed curtain cords, drooping vertically, like the Bridal Veil Fall in Yosemite; or say, what could exceed the stately grandeur with such a softened and graceful flow of sylvan elegance as is displayed by this truly "Vernal Fall" of the forest? Nor is this exuberant sport all of the "witch knot" origin, of Scottish renown, but, like that of the Sitka Spruce, must chiefly spring from more highly enriched soils and favoring influences indicated.

The bark on older trees is dark brown, thick, coarse, and rough; water-ways deep, flaring, or gaping, often broken and confused, and the general longitudinal fissure plan so jumbled as to bewilder the eye. In veteran forests they are more or less charred by periodical fires—not always the wanton work of man—for we have seen, several times in a single season, the scathing fires of heaven, gleaming from clouds, envelop lofty trees, hundreds of feet high, in one unbroken column of blaze, a perfect tower of fire, leaving the forest burning in its tracks months afterwards, or until the rainy season set in and stayed the raging. Strangers seeing many steeple-topped trees—spruces, firs, pines, and cypresses, especially in the young state—are apt to hastily infer this to be peculiar to California forests; whereas, we have really a greater number of flat heavy topped conifers than are seen in the Mississippi Valley.

This timber is exceedingly tough, rigid, and bearing great transverse strain, straight though coarse-grained; from the best localities, lasting; for long timbers of great strength, much sought after, *e. g.*, those very long mining pump-rods, sixty to two hundred feet long—in some cases two thousand four hundred feet or more long, the rod alone weighing many tons—counterbalanced by transverse walking-beams every two hundred feet or so; these solid timbers are about sixteen inches square. For bridges, frames, and strong rough work generally, of every kind, they are most superior.

For butter and similar boxes that require to be sweet and odorless, so as to communicate no taste or flavor to their contents, the wood is invaluable. It is the well established opinion of experienced lumbermen and miners, mechanics and farmers, that the timber is best within its middle belt, say three to four thousand feet altitude of northwestern and western exposures. Of course this altitude given is not absolute, but applies mainly to California from the north line of Mexico to Oregon. Besides other superior qualities, it may be noted this timber is not so hard to work, etc. In higher latitudes the isothermal lines dip lower towards the coast, and the average requisite temperature, rainfall, etc., accord the best conditions of vigorous growth. Lower down the mountains this tree is not at all equivocal. Far south the wood is red, more brittle, splits too easily, fails to hold the spike as good timber will, unrelentlessly; it is, however, said to be lasting. A tree so well known requires little detailed description. Suffice to say: The sprucy leaves are narrowly line-like, about one inch or so long, furrowed above, keeled below, margins smooth, recurved, and a little bluish-bloomy beneath; cones pendent from near the tips of twigs, long egg-form, nearly sharp pointed, three to five inches long or so, and about one or two inches in diameter; scales few, large, loose—but not shed off like firs—roundish, entire, and thin; the bracts above strap-like, projecting out beyond the scales lying along the surface and pointing towards the tip of the cone, ending in three points, of which the middle narrow one is the longest. Sabin describes the cones as erect, whereas they are pendent. Nuttall's figure represents the bracts reflexed; they are not so, but as we sketched them in Vol. VI U. S. R. R. Reports, page 34.

The recently discovered Large Cone (*Macrocarpa*) variety(?) of San Philipe Cañon, and elsewhere in the southern part of the State and to Arizona, perhaps requires more than mere enumeration. The form of this tree is rather more broadly conic, branches more horizontal, open, and airy in appearance; leaves longer; cones, scales, and seeds larger, etc. This large tree attains to one hundred feet or more high, five to six feet in diameter—quite as much diversity from the type as the restored *Pinus Jeffreyi* from the old *ponderosa*.

Woodmen and workers distinguish this one species into two kinds (or qualities?), Red Fir and Yellow Fir—the former with red, hard, brittle, and knotty heart or matured wood; singular enough, and contrary to the usual custom with other timbers, this heart-wood, by common consent, all reject as relatively worthless. The other kind has softer wood, with scarcely a feeble tinge of yellow; this is easier worked and highly valued, but deemed less lasting. Much more appropriate common names would be Red and Yellow Spruce.

MERTEN'S PACIFIC HEMLOCK SPRUCE.

(*Tsuga* [*Abies*] *Mertensiana.*)

"O hemlock tree! O hemlock tree! how faithful are thy branches;
Green, not alone in Summer time,
But in Winter's frost and rime!
O hemlock tree! O hemlock tree! how faithful are thy branches!"
—*German of Longfellow.*

Vast forests of this Pacific Hemlock extend along the coast from California to Alaska. Farther north it constitutes the main characteristic feature of the Pacific Sylva. This most charming tree of all the evergreens, from youth to prime, is of softened conic outline from dense broad ground-base, to light and airy leading tip; later on in life of spiry, steeple-top attenuation of branch and stem, throughout richly mantled with the finest feminine delicacy of foliage, yet beautifully infilled with the most exquisite variety and grace by numerous hairy, slender, and pliant tiny little twiglets, feathered, here in California, with the briefest leaf and thinnest of all the fan-form horizontal-expanse of spray known to these trees. This is even more spiry than the Eastern Canadian, and only rounded-conic when broken off by storms or far advanced in old age. These tall spruces, farther north, are clad in denser masses of darker green verdure—twigs of no longer strictly two-rowed foliage, but semi-plumed with longer and more varying leaves clothe them from the base to from one to two hundred feet or more; body two to six or seldom eight feet in diameter; but here only sixty to seventy-five feet, and rarely over two feet through, and in sheltered twilight shades altogether more open, lighter green, and delicate soft grey-green or glaucous hue most manifest below, or shimmering in the breeze, such sensitive forms and foliage in the play of lights and shadows is spirit-like, fairy, and sportive in the highest degree. And then behold the bright enlivening contrast of lighter vivid citrined-green verdure of new and tender leaf, fringing the new-born spring tips, her dark mantle now adorned, as it were, with new floral ornaments, or rather apart from all illusion—infantile sprays of exquisite beauty; delicate and drooping, confiding and reliant as the innocent babe on the breast of the mother—never yet excelled by any object of decorative art, nor ever surpassed in the exhilarating and refreshing odors they exhale—the delight and gladness of youth, the joy of age—rejuvenating ethers to the enfeebled, traditional restorer of the invalid, grace of the grove, beauty of the lawn! The scattered branches long and slender, of about equal diameter three fourths their length, horizontal, or the lower drooping with the easy upward sweep and spring awaiting the wintry snows and storms north; here, perfectly level, and free as the toss of the zephyr itself. Bark of young trees and branches nearly smooth, gray, bloched with lichens; old trees, coarse, rough-furrowed, inclined to a dark shade of red, a very slight bruise, or the scarf removed, reveals a very brilliant bright pink-purple color. Cones pendent from the tips of very numerous slender hairy twiglets; scales about thirty, roundish and thin, slightly furred, included bract on the back of the scale, blunt; cones an inch or more in length, oblong cylinder-like, somewhat pointed; seeds (about two sixteenths of an inch long), about as long as width of the wing, and this three and one half times longer—a few nit-like glands on the lower side of the seed. The northern form has the usual decided spruce drooping habit, as before suggested; leaves more densely set, and even crowded, and so distributed more promiscuously on the upper side of twigs—or less strictly observant of the two-rowed character, for although spirally set, upon a short raised base, and this still left on when the leaves fall away—they usually so twist at the base as to appear two-rowed; line-like leaves, though variable, are often three quarters of an inch long, blunt, sap-green above, two lines of bloomy-gray beneath; usually preserves the dense low bowing branches from little above the ground, so on aloft, inclosing a neat warm open canopy within, by the lap and overlying boughs closing at their tops; this greatly serves to keep the brooded soil warm, for the roots are shallow, and in Alaska rest on, and cling to, rocks with scarcely any appreciable soil at all, simply slop-holes of living and dead sphagnum—but here, altogether dry, only the roots reaching moisture—the sharply conic top at the same time serves to let in the sunlight and air to sweeten these woods. The thickened lower branches often so abound that much radiation and loss of heat is prevented in Winter and heat excluded in Summer—tempering the clime—besides, her foliage precipitates little moisture, unlike redwoods and their like, and as the snow melts soonest on her boughs, they bend down in the lean-to style of branch or center-pole and circle-tented. Viewed all round, it is manifest they shed their drip afar round about; this elegant sheltering foliage thickens deeper in or farther back, and multiplies itself amazingly. It not only divides and conquers the wind at the tips, but by successive subdividing sprigs, continually diverges and multifariously mingles the elemental strife, until all its force is fritted away, and the calmed air nestles quietly beneath her peaceful wings; therefore a lodge under these boughs is both warm and dry, fragrant and sweetly ventilated—indeed, constitutes that unsurpassed and ever-living sanitarium for the invalid to which we previously alluded. Camping out and sleeping on these boughs has a north continental reputation for restoring and rejuvenating, accordant with Norwegian and Swedish traditions and customs, where, once a week, the floor must needs be strewn with twigs of spruce or juniper tops. Is it any wonder these refreshing odors inspire the social home-circles with all the rural virtues that adorn these——

> "Lovely bowers of innocence and ease,
> Seats of my youth, where every sport could please;
> How oft I've listened o'er thy green,
> Where humble happiness endear'd each scene."

And where this old *sylvan nurse* reached her long arms out and took us by the hand, and we self-sufficiently climbed her arms, and, with loud echoing glee, sported among the entanglings; or, with dignified importance of great business in hand, selected the choice bough for the cross-bow, or more primeval bow and arrow of the native. It is noteworthy how admirably this tree rallies and thickens-in the top when broken off by the tempest—which full oft takes the conceit out of its too ardent aspirations—nature's testimony that it bears training to any reasonable extent, responsive to the bidding of the master; one of the best shelter trees known, wherever it will flourish at all, whether for the orchard, garden, yards, or for game of all sorts.

In our native wild woods, the cattle and beasts of the forest and field, and the fowls of heaven, find shelter under her shadow; the grouse, the squirrel, the jay and their like, find a constant home in the more darkened head—genial tent-house when storm and tempest roar, secure hiding place from alarm and danger, and ever present night retreat to hosts unnumbered, with the sweetest songsters of the grove.

To dwell on the vast and varied uses at length would carry us too far in detail—a final word on the California form, its timber products, economic, and few other uses must suffice. Contrary to experience and observation relative to most other timbers, the old matured heart-wood is more perishable than the young and sappy poles and branches where they are exposed to the seasons—perhaps because less interstitial separation of annual growths or "shaky" texture with such ready absorption and retention of water, etc.—hence its almost sole devotion to internal work, securely sheltered from alternate storms and burning suns; for rude rafters, etc., duly seasoned with the bark on, they are singularly lasting and very elastic, with much of the snap and spring of the yew and cedar, combined with a due degree of strength.

Only in the coast forests of California, contiguous to rivers or cold creek banks at the southern limit of its growth, is the Pacific Hemlock Spruce ever found much over two feet in diameter and about sixty or eighty feet high. Up to extreme age it preserves the perfect symmetrical spire-form, and is altogether less marred by unsightly dead limbs, than its kindred of the East—the same observation applies to Alaska. Perhaps if this tree in our forests, or cultivated in this clime, were more exposed, a somewhat broader conic style would supervene; however, in its native haunts the horizontal, open, and airy branches, subdivided branchlets, and final feathery sprays have the utmost strictly two-rowed leafy plan, the tiny line-leaves about half shorter—certainly the most delicately gauzy, chaste, and beautiful tree it is possible to imagine. In the young state, say from ten to forty feet high or more, the bark is relatively smooth and even, branches exactly level, thin, fan-like, long and slender, with cherry-brown bark. These free hearted boughs from the breast, are wont to lose entirely the peaked Italian brigand-hat or Alpine style so common elsewhere, not even pending like tassels at the tips save when in young springtime, but toss their entire limbs as lightly and freely to the breeze as the wild deer leaps on the mountains; or, astirred by the gentler zephyr off some sunset shore, vibrating the softest silvery emerald sheen, like a celestial thrill, close along the confines of the invisible, or dimly seen, so ennerved are the tiny leaves of this tree of our earthly paradise that no artistic grace of pencil, or power of pen, can express the charm of every exquisite form and enlivened motion, even to the very minutest. Indeed, it is, in every way, the apt and recognized* emblem of juvenile *innocence* and early perceptivity.

The timber is well known the world over—chiefly, as noted, for internal work—this being tougher, seldom shaky, less pin-knotty, clearer and straighter-grained; makes good frames and floors, ceilings and laths; also, masts and spars, etc., although the Russians seem to prefer the Sitka Spruce (*Tsuga Sitkensis*); the bark is of wide repute for tanning; fibrous roots yield the strong thread and cordage for seines, nets, and for sewing or lashing the birch-bark canoe or boat of the native; the crude gum-like balsam smears and water-tights the

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* See Meehan's Obs. on the E. Hemlock; also, German Literature.

same—refined, it is the Burgundy Pitch of the apothecary, from whence come the renal and sciatica plasters—and the inner bark itself is also used for a sticking-plaster of much renown. From the tender twigs, or their extract, the wholesome spruce beer is still made, as in the days when we were young; a kind of oil, also like spirits of turpentine, and the lamp-black, scarcely inferior to any his sooty highness ever saw. In short, in medicine it has had and still holds a good reputation, as balsamic, sudorific, anti-rheumatic, tonic, etc., and for scrofula, even better than brake—equal the oak—and for unnumbered "ills that flesh is heir to."

WESTERN WEYMOUTH MOUNTAIN PINE.

(*Pinus monticola.*)

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* * * "Seemed an osprey,
Hovering above his prey—and yon tall pines,
Their tops half mantled in a snowy veil."

The Far Western Mountain Pine of the Pacific bears the strongest resemblance to the great Sugar Pine, of which it seems almost like a smaller variety of the same species (hence designated Little Sugar Pine). The general contour and expression of the tree is scarce at all like the White Pine (*P. strobus*) of the Eastern Atlantic; true, it has the common cone characters of the thin scaled Strobus section, and five-clustered needles as in Lambert's Sugar Pine also, but the port and form, as indicated, is as distinct as it well can be for one of the same subdivision of pines. Before the tree has attained to its truo matured and distinctive type, it has the common closer form of many other species, but at length, when of age, and aloft from seventy-five to one hundred, or sometimes one hundred and seventy-five feet high, and from two to five feet in diameter, in full bearing, its long horizontal branches well poised and nicely plumed with little laterals and closed around with faintly softened sea-green leaves, two and one half to three inches short; and then there is the selfsame free spread of the great Sugar Pine, only peculiar to these two species; the five-leafed clusters of needles are set close together in short fugacious boots, points sharp and edges keen, margins finely but remotely toothed, two sides channeled; the short but exceedingly slender foliage thrills very sensitively and delicately, the softer celestial echoes from off the blissful shores, to lull and soothe the sense to peace. Let other pines chaunt louder and grosser songs from their sylvan choirs where old Æolus dwells, these are of the higher angels who are wont to whisper their love notes low and still, as from the far away isles of the blest, soft as morning zephyrs gently roll the grain-clad dells. The form and size of the cones that cluster and tassel the tips of the branches are quite like those of the White Pine (sometimes called the Soft California White Pine)—oftener a little longer; herein the resemblance is nearly perfect, being alike on short stems, cylindroid, four to eight inches long, one to two thick, and stiffly curved; scales smooth, thin, loose, abrupt and mucro-pointed, but not prickly; seeds small, one fourth of an inch long or so, mottled or spattered with brown; wings from two to three times as long, widest near the middle, diagonally pointed, translucent-creamy, and more or less striped with brown; cotyledons, six to nine.

Contemplating these conifers, distant from their alpine eyrie, we behold the Great Sugar Pine stretching his wide wing-branches against the sky, like a vast sylvan condor soaring aloft high up over all contiguous trees; so, also, is seen this lesser Mountain Pine as a sylvan osprey sailing serenely o'er the mountains—tree-hawk of the hills, circumspecting the groves!

This soft pine of the Pacific is found sparsely distributed over the Sierra Nevada Mountains, at from four to eight or nine thousand feet altitude; timber similar to the white pine, but neither quite so white nor soft, and the texture somewhat tougher.

THE GREAT SUGAR PINE.

(*Pinus Lambertiana.*)

"Beneath the forest's skirt I rest—
Whose branching pines rise dark and high,
And hear the breezes of the west
Among the threadlike foliage sigh."—*Bryant.*

One of the most magnificent pines the world ever saw is the Great Sugar Pine of California! From one hundred and fifty to three hundred feet high, ten to fifteen feet in diameter, the body remarkably elegant and even of surface; for the fine water-line ramæ only serve to smooth and soften the neutral-tint bark of this tallest priestly pine; and what a wonderful column! perfectly cylindrical, clean of branch or knot for hundreds of feet—usually two thirds of the total height—as it stands conspicuously in the midst of the forest, denizened among other wildwoods, yet exalted above them; and high up over all his kindred pines, in some remote degree, like the lofty palm tree of the tropics. Among the trees, a mountaineer of the most decided and commanding character, his top in sylvan glory and radiating its open but exceedingly long arms, widely spread afar towards the horizon, oft as one vast long bow at ease, upwardly curving, exhilarant and free; and yet they are neither naked nor lank in the best types, but side-plumed and grandly fringed by relatively short, lateral, and successively diminishing branches and branchlets to their main extremity's end, whence pend from one to three, or even five, very long cones tasseling their tips, from one to one and one half feet long and three to five inches in diameter, suspended by stems four to five inches long; color of cone light cinnamon-brown or ripe-yellowish; thinnish scales loosely overlapped, oblong fan-form, without prickles, etc.; seeds oval, a little compressed, lines long, wings widest below the middle, obtuse; cotyledons, thirteen to fifteen.

These long horizontal limbs may depend somewhat, more or less in old age, like the bow still on its back, not altogether unstrung, but they are never massed nor at all crowded, but always open so as to allow the wind—of the prominent storm-exposed head—free passage through, or, in extreme cases, only bending them leeward almost double, like a true Damascus blade—hilt to point. This remarkable length of limb, so tolerant of the tempest and vigor of recoil with returning calm; or, in other words, toughened strength with elasticity, is quite characteristic.

The wild red man of the wood is quick to perceive and apt to apply this and similar knowledge to the science of his own use, for no sooner does the harvest of the coveted *piñon* arrive, than ape-like, he climbs and clambers out astride the branch, and, teetering to the required sway, when, with a short timely jerk, the heavy cones are snapped off. The great use of the seed as Indian food we omit.

The rich dark plumes of vigorous blue-green foliage very much resemble the beautiful White Pine of the East (*P. strobus*), especially when young—at length all further resemblance of form ceases. The needle-like leaf-straws are rather short, and somewhat twisted in age, from three to five inches long, very finely toothed on their edges, five in each tiny bootee, which at length is shed off like the White Pine; these little bundles, in most cone-bearers, are more manifestly inserted in spiral order around the ultimate twigs.

The timber is not quite so soft, light, and white as the White Pine itself, but closely resembles it, and is alike in use and value, and, in some respects, superior, as it combines greater strength with elasticity.

Where the surface is burned the oozing sap concretes into a white manna-like sugar, sometimes nearly as crystaline and pure as refined loaf sugar, very sweet, with scarcely an appreciable pine-resin flavor —hence the common name Sugar Pine. If this could be obtained in quantity, its laxative and balsamic properties, apart from the palatable and nutritive, would highly commend itself to the attention of the medical profession. For obvious reasons, we cannot here, in all freedom, urge upon the public or the landscape artist the full claims of this expressive tree—to the bald scientific, or the mere lucre-loving plod, any æsthetic estimation of arboreal nature whatever might be deemed too poetic, imaginative, discursive, fanciful, or what not; briefly, irrelevant to the subject in hand. And what if we own no property in that royal realm, why shouldn't we be indifferent? And even our aversion may be suppressed. Is it not one of those occasions for tolerance, and charity, and all the renowned and universal virtues among men? With due deference, therefore, to these varied tastes—always to be anticipated—we frankly confess our great surprise that even some few are found disparaging this noble pine on account of its open-hearted port, nor in our fascinated simplicity did it ever occur that the lack of leafage was a defect in this unique type of trees, being in no way amenable to any gross, massive, or tumuloid standard of judgment; set it down, then, to our fault, that we have no preconceived, abstract, and arbitrary notion of propriety for all the trees!—that we do not even bow down and worship the almighty *Scissors!!* Perchance the peculiar charms of this tree in our eye, may, to some extent, be borrowed from the striking contrast with other associated trees, for it is rarely in forests of its own, being mostly interspersed in all the Alpine, and some of the subalpine regions of the coast. To our taste, the Great Sugar Pine hath the far-extended oratorical gesture and open magnanimous spread from the breast and top of a tall and representative, or corresponding type of some sacred benediction of "good will towards men," for trees always display in their bearings types of human attributes.

On the table-lands of middle Yuba, a fair sample of a grove may be seen; indeed, almost anywhere in the common belt of about six thousand three hundred to seven thousand feet altitude; always excepting that peculiar medium coast-tempered belt that connects the Coast Range Mountains and Sierras, above and around the head of Sacramento Valley, where a few come down lower, in groups rather than groves, or very much more sparsely; where, also, they develop but few cones, comparatively, even in favorable fruitful seasons, and most of these, say two or more, become abortive, and it is well if even *one* of the number matures; besides, it should be noted the cones are smaller, yet always characteristic.

Found more or less in all parts of the State, namely, on the Sierras from three to eight thousand feet of both slopes, and a few in the highest points of the Coast Ranges from Santa Lucia Mountains to Humboldt County, and so on northward to the Columbia River.

Between the two forks of the Stanislaus River may be seen a tree three hundred feet high, and about fifteen or sixteen feet in diameter.

PARRY'S PINYON PINE.

(*Pinus Parryana.*)

"Mid the pine tents on the moon-lit mount,
Where silence sits to listen to the stars."—*Harvy.*

We have more princely pines than this, which commemorates the indefatigable labors of our very worthy friend, Dr. C. C. Parry, but none of such exquisite beauty of symmetry, density of foliage, eminent use and rarest of all rare foreground trees for limited or lengthened landscapes. Mainly by its moderate size—from thirty to forty feet high by one half to one and a half feet in diameter—which greatly commends it to limited lawns and for rural residences, as most species of evergreen and deciduous conifers are too colossal, or if lesser, too spreading for common purposes, being so liable to crowd contiguous trees and shrubbery out, for only a few, like *Chamæbatia foliolosa*, etc., thrive under their shade or drip; then, again, they prove too dark and monotonous, even when of requisite size for middle or foreground use; are sometimes of exceedingly slow growth, and do not well bear near approach and more critical inspection; above all, the light gray mealy-green or glaucus bloom of the leaves of this species is even more striking than the gray-gauzy Sabin or Large Nut Pine or the common Pinyon (*P. monophylla*), besides being of more rapid growth—bark light gray and smooth above, rougher below. Parry's Pine, in youth or prime, is rather steeply pyramidal, perfect in outline, compact in close foliage, but, judged only from trees of great age that have struggled desperately upon poor burning or bleak exposures of rocky ridges, they are reported with a round top, just as we see in those allied nut pines, cypresses, and similar trees, according to respective situations apart from their natural habit, which distorts and renders their forms, in a great degree, abnormal.

The timber is in great request where so little else is to be had, but the quality is not well known. The edible nuts are small, and hence others are preferred by the Indians. To them the pinyon is inestimable—a very feast of fat things; this is another of half a dozen or more nut pines. This is readily distinguished from Pinyons *par excellence* by the number of leaves in the little boots or sheaths. These needles or awl-like leaves are short, one and a quarter to two inches long, three to five in each bootee—usually four; cones somewhat globose, from one and a half to two inches thick, with strongly elevated knobs on the top of the scales; seeds oval, barely one half of an inch or less long, with a thin light-brown mottled shell; cotyledons, eight. Found only near the southern boundary of the State.

HEAVY YELLOW PINE.

(*Pinus ponderosa.*)

"There is a quiet poetic spirit here, amid
The silent majesty of these deep woods—
Its presence shall uplift thy thoughts from earth,
As to the sunshine and the pure bright air,
Their tops—the green trees lift."—*Longfellow.*

The Yellow Ponderous Pine of California and Oregon covers vast areas of several thousands of miles in extent, from beyond the Columbia River to Mexico, and from Coast Range to Sierra Mountains, with the most magnificent forests, not only mixed with other pines, firs, spruces, and varied arborea, but still maintaining its prevailing character; it also often becomes the only species the traveler may meet for days together, especially in the arid and burning interior valleys and basins; and even here it is often a large tree, *i. e.* over one hundred feet high, suffering somewhat in the character of the lumber which then becomes softer, lighter, and is greatly given to an ungainly warping propensity that seems simply ridiculous, when posing to such extremes. Like most other trees, the quality of the timber is exceedingly variable, according to soils and surroundings. To illustrate and confirm this remark, we will state that a dwarf variety, or rather subvariety of *Jeffreyi*, in Owen's Valley, at "Casa Diablo," bearing cones, barely one half the usual size, within reach from the ground—the full grown trees but little higher than one's head—with glaucous sour foliage, of the taste of common rhubarb or sorrel. At first view, we took this remarkable example to be a new species of pine, but upon more close and careful examination, although growing upon exactly the same level and within a few stone-throws of typical trees over a hundred feet high, yet this dwarfed character seemed evidently due to the soil in which this particular group grew, being a saline deposit from a hot spring, forming a little knoll whence the mineral waters had receded in course of formation.

The ever increasing import of all our varied Pacific observations tends to impress upon us the vast significance of foundation soil—as to accelerative or depressive, qualitative or quantitative, and other influences, upon arboration, or the lesser and more general vegetation—many fingered facts point continually to the ultimate mineral and moraine as their great guiding genius; so the lesser mineral flows to the lasts and leasts, æreal and ethereal; a thousand witnesses rapidly multiplying, crowd to the front, and clamor for recognition and application to human use, or to use and to humanity. The artificial dwarfing of trees by the Japanese—a former mystery, now generally known—practised by myself when a boy, viz: by the layering principle, modifiedly applied, from upon trees already very old, by partially and successively continuing to belt or girdle a twig while the limb is wound round by turf or moss with a suspended water drip until it strikes radicles, and then cut off and potted or planted. This pine, from one to three hundred feet high, and from three to eight feet in diameter, is, for nobility of port and lofty beauty, in the eye of the cultivated stranger, possessed of unusual interest; the finest forests are but little removed from the great *sequoias* themselves; this comparative contrast is most vividly brought home to one's consciousness by their often skirting, and as it were, guarding the regions round about them; nor is it always their grandeur alone that so impresses, for to be duly appreciated we must enter into the spirit of the tree itself, in various ways; must catch the silvery thrill that so nervously and finely trills over the long radiating tufts of steely needles that tip and aspergil the older beady-scarred boughs; and then there are those large long plumes of younger spire-topped trees, which are altogether alive to one who

"Loves the wind among the branches."

Though the palisaded pine trees—ever singing—ever sighing as they softly gleam o'er the landscape, tinted, too, with the most delicate possible tinge of golden-green that glimmers a softer sheen over the sunlit hair—these coma almost hiding the clustered cones that tip the final twigs. The bark is peculiarly striking, of bright yellowish-brown, and of lamellated soft corky character and color, its surface laid off in large, flat, smooth plates, from four to ten inches long or so, one third to one half less broad; these oblong divisions, for the most part, follow the law of cell forms and forces combined, bounding the chinky water-lines, the leading channels of which are somewhat deepened below. The ease with which jaybirds and woodpeckers honeycomb their thimble-sized holes and drive in their winter supply of acorns, point or germ end foremost, renders the bark of these pines the preferred repositories; even bushels of acorns are sometimes seen so stored in a single tree. As the germ end is thus kept dry, and by pressure quite prevented from swelling, it cannot germinate, although some species are so prone to sprout they scarce wait until they fall to the ground and never long after—a hint to the wise is sufficient.

Although this Far Western Yellow Pine comes in second above Sabin's Gray Pine as we ascend the Sierras, and is very abundant and of the best types on the higher ranges, more especially east, yet it is also a Coast Range pine—in this latter region the cones are much smaller, seldom over three or four inches long by two to two and a half inches broad, and the brown seed, although rounder and not so sharp, is about the size of apple-seed; whereas, the *Jeffrey's* form (by some considered a good distinct species, certainly a quite characteristic variety for the culturist), found at middle and higher altitudes, has cones at least three or four times as large—from six to eight inches long by four to six broad—old straw beehive shape, and striped or variegated, seeds twice the size. Where transient mountain streams lave the roots, and perhaps other conditions favoring, the cones are often more elongated or not so strictly ovate-conic—this we take to be the *Beardsley* variation—and so others besides the extremes one sees beneath every tree, but the general resemblance of the several synonyms of the type is such that it may warrant their union into one species, even if we reckon them eminent and choice varieties. Some of these majestic trees, seventy-five to one hundred or one hundred and fifty feet high, are found with massive spreading branches of peculiar aspect, unwonted among pines; but for the most part this species is towering, lofty, and clean colonnaded below, hence its availability as timber for manifold economic uses. In a brief historic point of view, as connected with this pine, it may be well to note the import of those little basins or ring-ridges of sand so often seen encircling the base of these pines. It is the work of the Indian —designed to entrap and collect the fat luxurious worms that infest these trees—who, firing the straw on the still air of late Summer and early Autumn, the rising smoke among the boughs offending them, they let go, swinging down to the ground, whence they betake to the trees again, and, falling into these pits, their futile hold upon the treacherous sandy margin causing a continual backward tumble into the bottom of these shallow pits—thence the squaws gather them into baskets for food—thus a double purpose is subserved: that also of cleaning the ground preparatory to the fall of seed.* In allusion to the pine, the native, in a metaphoric sense, often unwittingly bears the highest testimony to his great estimation—judging from their highly figurative style of speech, graphic force, great eloquence and pathos, of many tribes of North America. We say, judging from his choice of words and figures, his wild woods and high mountain home must have for him still much genuine poetic charm; perchance sounder significance than the pale-face is wont to perceive, akin to, if not the real relic, of a lost Eden of some celestial bygone. Take as an example the Chief Saginaw, when asked of his welfare and that of his family (two lovely daughters meanwhile having died), characteristically answered (pathetically breaking a long, fixed, statue-like gaze of silent retrospection): "Saginaw? Saginaw was once a tall pine among saplings of the forest! The pale-faces came and sold him fire-water; he became depraved; the Great Spirit's anger was kindled against him, and His lightning struck away his branches!" Long may they wave their fadeless banners aloft to the pure mountain breeze, and sing their sweet æolian spirit-song to entranced and

* As miles and miles of forest—not a tree less than two hundred feet or more high—may be summarily divested of their caterpillars simply by women and children, what shall we say of our own stupidity if we do not learn how, after seeing it done before our eyes? Now why not thus free our tiny patches of woodlands, fields, orchards, rural and municipal shades? With plenty of fire and smoke, men, women, and children, and a little civilized sense left yet! certainly none will say the plan is not practicable. But suppose it may not apply to all cases (none but an empiric would ever be foolish enough to think that, in the first place), nor to any, perhaps, if we scorn all insect lore (Entomology). Sneer at it as "bugology," and its devotees as like "ologists." Thus doing, certain and sure, old Prince Belzebub hath dominion over us, to our sorrow, and we shall wail to no purpose! Doth it not stand to plain common sense and reason, that even a savage must know their habits, times, and seasons? and should not his enlightened brother search more deeply still, into wider relations—perchance into the realm of causes? No empirical or quack nostrum alone is adequate to meet our ills and failures, like clear intelligent ends—like scientific knowledge, wisely applied to use. But the objector may say: "Suppose the land isn't sandy?" well, then make your little trenches shelving, or with a regiment of turkeys and a few other lesser native birds, the good All Father sends, none may be needed; indeed, a thousand considerations could be urged, which every man's own good sense can be trusted to apply. These observations are not irrelevant, neither are they discursive; no one thinks of treating trees, plants, or animals nowadays apart from their relations, for no man of sense can so think on any subject.

fondly listening ears, soothing the soul to peace and to inner contemplation.

This Ponderous Pacific Pine is so called from its great weight, the timber being unusually heavy from its dense, generally resinous, often hard and brittle character, although, as before observed, softer and tougher in the middle Alpine belt of about six thousand feet or more. Wood usually yellowish, largely appropriated to mining, building in general, and for a great variety of useful purposes—among the best timbers of the Pacific.

This tree, like the Long-leaf Pine (*P. Australis*) of the south, to which it bears strong resemblance in general appearance, is rather more apt to be blown over by high winds than most other pines of this coast.

SABIN'S GRAY PINE.

(*Pinus Sabiniana.*)

> "Pine trees waft through its chambers,
> The odorous breath of their branches."
> —*Longfellow.*

This medium sized, soft, sea-green, light, and airy pine, is the first seen as we approach the highlands, which, like a blue sylvan mist, sports itself here and there over the foothills in a manner so eminently pleasing to the eye. Being a first class foreground tree, where else should it be found so appropriately as on the foreground, or middle landscape, as we ascend the Sierra Nevada Mountains? and, if allowed to say it, we never behold her soft celestial wings without a genial glow of heart that, as it were, clasps the chaste charmer to our bosom—and why not? Is there the remotest semblance of prudish precision in the expression of this tree? Nay, but the whole air of it is as free, easy, and artless as any other child of nature, with only just enough of the erratic for grace and variety's sake, for the body is never, or rarely ever strict, but will swerve a little below, and must needs fork more or less variously above; usually dividing into two or more main, erect branches, that serve to divide if not dissipate any leading responsibility of head; and, as to timber body, there is not often much to speak of, therefore doth it spread and become gently open, and is not only of light gray-green hue, but loose and gauzy-foliaged, with long-haired leaves quite gossamery, like a lady's veil, that scarcely hides the beauty beyond, but lends distance to enchantment and relief to perspective. Still, lest the expression be altogether too light and too gauzy, the great cones are dark and striking objects, hung out in mid-air! speciously as big birds among the branches, or, recalling the allusion, they give it decided tone and character. Let us dwell a moment on these great cones—unequaled in the world at large, and only a little surpassed by the monster Coulter Pine cone of the coast at home—eight or nine inches long by seven or eight inches in diameter. This alone is enough to excite the wonder of the native observer and astonish the stranger, and yet they are often in clusters of from three to five.

This particular nut-pine—for there are more than half a dozen others—can only be considered a tree of low or middle-sized stature, say about forty to sixty feet high, average diameter two or more feet—rarely a few seventy-five to one hundred or more feet high by four or five feet in diameter—but as they nearly always divide, as indicated, into a few erect pseudo leaders, as well as large somewhat spreading branches, and these often continued not far above reach from the ground, the grain-fibres become irregular from this cause alone; besides being intrinsically wonderfully tough and withey, wood white, light, and soft—reputed our best timber, for ox-yokes especially, and ox-bows also occasionally, but for this latter purpose laurel, ash, larch, willow-root, or Eastern hickory, etc., are better; it is also appropriated to saddle-trees, on account of its great tenacity and lightness.

Notwithstanding its numerous uses, lumbermen do not consider it "timber" in the appropriated commercial sense, although here and there a sawlog or two may be obtained from a single tree, and which makes real good inside stuff for ceilings and the like, but is soon perishable when exposed to the weather, save only the pitchy knots; but for oven and kiln-fuel, where well distributed heat is requisite, it is worth two hundred to three hundred per cent. more than the best of common firewood. For pottery purposes, also, it is far preferable to the intense heat of manzanita. Yields an abundance of excellent turpentine and a superior oil; if bark-girdled before cutting, would pitch well and be valuable for making tar. These trees, however, are seldom if ever seen in dense groves, but sparsely distributed over extensive areas—well on to one thousand miles of the lighter hilly lands of California and Oregon—they also inhabit some of the most utterly sterile, rough, and rocky soils imaginable, and even these lands first peopled with trees would thus serve to sustain a pretty large population; the nuts, even, might become an important article of commerce and source of national wealth. The central, continental, and Pacific pine-nut crop, properly harvested, would far exceed the wheat crop of California. Few are wont to duly estimate its value for human sustenance alone, apart from animal sustentation. Speaking of the nut crop in general, of course we include also all the pines, as *Coulteri*, *Torreyi*, *monophylla*, *Parryana*, *albicantis*, *flealis*, *Lambertiana*, etc.; indeed, it would not at all surprise me if one species alone of the list could be selected that would exceed our entire boasted wheat crop. It is really remarkable how few of these seed suffice for very long and fatiguing journeys. Viewed from the native standpoint, is it any wonder the Indian will exchange your chippy baker's breadstuff for his delicious "piñon" and acorn "pone?" This very nutty, rich, and delicious diet they are apt to feed upon too exclusively, continuously or inordinately, and in such cases the great excess of oil lays them liable to boils and the like, as in our own similar childhood's experience and maturer observation. Coveting a change of diet, we have watched the Indian go forth a day's journey to procure meat, taking neither bow and arrow, gun, nor any other weapon nor trap, and yet return in the evening laden with booty. The reader may be curious to know one of his ways and means, *e. g.:* Provided with a few pine-nuts, as usual; finding squirrel haunts, he raises one edge of a flat stone upon another, propping it up with one of his "piñons" set endwise; Mr. squirrel gnaws one side, weakening the support, when down comes suddenly the dead-fall and secures him, and so at eve, passing from stone to stone, the long string of fat squirrels is no longer a mystery.

So much confusion has hitherto arisen by mistaking this pine, in numberless ways, up to a recent date, that we may be indulged in a few details and reviews, especially of the more striking contrasts: First, it is oftenest mistaken for the Greatest Coned Coulter Pine (*P. Coulteri*) of the coast, but that is a cling and close-coned pine; this Gray Pine is loose, opens and sheds out its large cylindroid seeds so soon as ripe, and for the most part forthwith falls away; is darker mahogany-brown, shorter, and relative to length, broader; shaped more like the old fashioned straw beehive. Whereas, Coulter's is of lighter color, raw umber-tint and oblong, say about one third longer; the hooks of the scales larger and longer, some often two to three inches long, Sabin's being shorter and more flattened; seed-wings of Coulter's dark-brown, almost black like the seed itself, besides it is obliquely obtuse, four or five times as long and large, and yet the seed itself is much smaller, one third to one half the size, somewhat flattened and trianguloid. In Coulter's, also, the leaf-straw is much larger and longer, bigger and longer boots, club-footed, more manifestly scaly, scales fringed or eyelashed at the tips; the lighter colored leafage has very little of that delicate blush of sky-blue; in short, the whole aspect of the tree is distinct at all stages and in all conditions of growth, from top to toe. It seems almost a loss of time and valuable space to enter into a fuller review of what a tree is not, when there is so much to be said or written of what it positively is. But why we should still continue to copy old errors in topography is not so easily accounted for, since all the world observes, or is presumed to observe, them along the great continental thoroughfare of the Central Pacific Railroad.

This Hooked Bull Pine, as the pastoral herder has it, for he sees bovine horns in the hooks, is said to have been first found "on the Cordilleras of California at a very high elevation, one thousand six hundred feet below the region of perpetual snow," afterwards nearer the seacoast lower, "but almost invariably on the summit of high elevations on the mountains," etc. Now the fact is, this is emphatically a foot-hill pine, some say as low as tide-water; but we will say two hundred feet of the sheltered Coast Range, rising east of Sacramento Valley towards the Sierras, to four hundred feet as the lowest limit, from thence it reaches two thousand five hundred feet altitude, or even more, of our snow mountains, and on the cold exposed coast mountains of St. Lucia about the same. According to Hon. B. B. Redding's careful and exceedingly useful Sacramento Valley observations, this pine is not at a higher elevation than that in which the temperature is the same as that of the valley in the same latitude, but it also indicates increased rainfall in these contiguous homolatitudinal valleys, hence plants, crops, trees, fruits, etc., growing in the valleys can alike be successfully grown on these foot-hills, due shelter and aspect given, with the additional advantage of purer air, more equable, drier, and healthier; free from fogs that retard if not preclude the ripening process, discoloring almonds, nuts, and other fruits they do not sour and utterly spoil, as peaches, grapes, and all Autumnal fruits, together with the genus homo; and the further advantages of sweeter and more wholesome water, better drainage, longer ripening season on account of later frosts and more gradual "closing-in" season, by the coöperation of earlier droughts; and when the growing season is closed, more perfect rest—consequently fruits of richer quality, etc. And even the frosts and snows that do occasionally occur here—lay their soft and downy mantle so quietly over the vernal ardor that ever broods over these semi-tropical little hills—that they are only lovingly chastened and withheld from the premature exposure of these sentinels and harbingers that patiently await the earnest call of Spring. Thus invigorated for intenser reaction, at length they go speedily on, prospering and to prosper, until they win the final goal of "Autumn's farewell smile"—the best, the richest garnered fruits of the Pacific.

This Largest Nut Pine and Digger Pine, as it is also called, we have seen to be a tree of unique beauty, expressiveness, and manifold uses, as in some sense suggested, with bark of body and branches also of similar leaden gray, and moderately even; but if this gossamery gray-green cerulean almost smoky Indian-Summer sort of haze foliage is to be designated "a compact mass of deep-green verdure," why then one might as well close the eyes—their occupation's gone—observations, like oracles, silent, and classic responses forever dumb. Nor let it ever be presumed that a thousandth part of the knowledge, significance, and use of this pine, or any other subject or object in nature is entirely understood. The word "exhaustive" belongs nowhere in the vocabulary of God's works, and is ever abhorred by the wise; such expressions belong to the lip of the viper of the tree of science—never to the tongue of the true man.

THE GREAT-CONED COULTER PINE.

(*Pinus Coulteri.*)

> "Where the wind
> Could linger o'er its notes, and play at will."
> —*Arnold.*

This is a noble pine in all respects that regard the landscape or rural adornments, yet seldom collected, often omitted, briefly and imperfectly noted, sometimes mixed and mystified by being confounded with allied species. No pine of similar size or similitude, such as Sabin's and Torry's, can compare with the Great-Cone Coulter Pine in dignity of expression, whether we regard the more massive limbs which come out thickly and apparently irregular here and there at all points, alternating as the spiral plan in trees necessitates (hence more easily climbed), or if we regard the unusually long and large foliage, a foot or so in length, of sober light-green hue, but not near so gray or glaucous as Sabin's slender straw, and longer than Torry's stout and long straw; the boots large and club-footed, formed of broader, distinct, light-brown scales, fringed on the margins, etc. But when we come to regard that monstrous cone—the largest in the known world—with claws of a grizzly bear, we begin to appreciate a few of the details that give so much force of general expression to the tree.

Remarks applied to the northern forms of this vicinity, and to those found upon open hill-tops of the coast mountains, must be somewhat qualified when seen in the deep gorges of coast canyons farther south, for in such situations any one must see they would have less spread, and from being flat or round-topped, they do actually aspire to a conic summit, and these trees become more than one hundred feet high and from two to four feet in diameter; here, instead of having single sugar-loaf cones one foot to a foot and a half long by seven to eight inches in diameter, they have enormous clusters of from three to five of these prodigious cones! the great hooked scales, or rather the terminating hooks alone, from the top of the disks, being two to three inches long; *i. e.* near the base of the cone. We have a sketch made from the one in the British Museum. These are of the close and cling-cone type of pines which do not open; but retain their seed for many years, at least on our coast; whereas, Sabin's pine, with which it has been confounded, sheds its seed so soon as ripe, and the cones forthwith fall off. An empty cone is, however, now and then held over on *P. Sabiniana*, but this misleads no one, for the form is by no means the same, nor are they ever of the light clayey or raw umber color of the Great Coulter Cone; nor are the leaves alike as to size, length, or color. *P. Torreyi*, it is true, does not let go its seeds so readily as *Sabiniana*, but its roundish smaller cone is of dark purple-brown or madder hue, and in neither of these is the wing of the seed of any particular import, while this has much smaller flattish black varnished seed, and very long large dark brown almost black wing, and though stiff, is not so thickened at its grasp of the nut, etc.

This pine, like Torrey's and Sabin's, insignis and others, is of equally rapid growth, yet few are found with clear shaft, the limbs usually coming out low, often near the ground; thus it seems little suited for sawlogs, and if it were so the lumber is of little value, save as a dernier resort, on account of such an ungainly warping procliv-ity. To recount examples would partake too much of the grotesque for sober narrative; your house would go into spasms; no Jack nor joiner could make or break joints; your doors shut at one end and open at the other; children born crying with one jaw out of joint, and your pigs puzzled to know which side of the fence they were on, after the most strenuous efforts in their way. In short, the lumber is altogether too impracticable for common use.

MONTEREY PINE.

(*Pinus insignis.*)

> "Along the pine forests on the shore,
> Rolls the gathering melody."

Perched close upon the Pacific shores, from Pescadero and Pigeon Point to Monterey, and south to San Simeon Bay, this pine catches the last celestial sunset glow that "fires the tops of the tall pines," and is the favorite conifer of the coast, so universally in cultivation in the vicinity of San Francisco. The best evidence of adaptation to this and similar soils and climates, is found in the fact that concentric rings of annual growth from one to one and a quarter inches thick, and perhaps even more, can be both seen and well substantiated by corresponding history and date, thence showing an average increase of a foot in diameter at least for every seven years, from the seed; and this in the commonest light soils, without care. Seeds sown broadcast and left alone to nature, where stock is excluded, have given very nearly like results. No other pine, native or foreign, shows greater vigor here; in short, instances are too numerous and notable to need lengthy confirmation, and few in early age exceed the symmetry and dense sheltering qualities of the Monterey Pine.

Their value for these purposes as forestal woods contiguous to, and especially to the windward of orange, olive, and vineyards, or orchards of every kind, is too well known, however little appreciated. This tree, like many others, although bending to the lea, under persistent and powerful northwest winds, a short lull is sufficient for it to right up and pursue its natural bent. From branching close to the ground for a decade or two, or after the early and middle period of growth, then later on in age, it is wont to relinquish the first relatively long and strong arms of juvenile contest below to its juniors and their companions, the Knobby Pine, etc., and thenceforward aspire to a higher destiny in the heavens—donning the picturesque in pose—challenging the elevated buffetings of the elements up in the blue; for this tree, it should be noted, attains to one hundred feet and upwards in height by two to four feet or more in diameter. Bark dark brown, thick, deeply fissured and broken; leaves four to five inches long, margins of these needle-straws finely saw-toothed, in threes, short boots, one quarter of an inch or so, smooth cheery-green; cones shaped like a Farralone egg—the murre or foolish guillemo, etc.—only obliquely one-sided or greatly swelled out and knobbed on the exposed side at the base, for the point is bent down or back close against the tree, three to five, in whirled clusters; the somewhat diamond-rhombed disk, short recurve-prickled in the center. These close cling-cones are three to five inches long by two to four thick; color light umber to cinnamon-brown, smooth and shining; requires two to three years to ripen well, and remain on much longer; seeds black, tubercled, about one quarter of an inch long, wing three or four times as long, widest above the middle; cotyledons, five to seven.

The timber is very tough, and while more abundant, in great demand for a thousand useful purposes, but the supply soon failed and gave place to the redwood and other more northern coast lumber.

This incomparably quick-growing pine will, ere long, be in the greatest demand for seed to reinstate those treeless tracks and mountain ranges along the coast with those sweet æolian forests which so much improve the barren soil, conduce to the salubrity and equable geniality of clime, to economic demands of home and commerce, utility of pastoral and arable lands of the interior of the State, especially south, where the greatest lack is felt; and even the existence of orange, olive, and vineyards, and fruits and fields in general, may yet be found to require them, for they retain, distribute, and precipitate humidity, and thence springs and streams are maintained for all the indispensable wants of life. A wiser generation may yet find and apply the ways and means in the light of a genuine public policy, which will be known and recognized, in very deed, to be of the utmost importance to the welfare of every settler and citizen of the State.

A people wont to set at naught nature's laws, are doomed by their own acts to ruin—extinction—and must soon give place to a nation working right-use-ness. They render possible general and varied culture, adequate to human wants, to secure an ever ensured prosperity; not simply measured by the common standard of more manifest and merely utilitarian wealth, they are indeed the great continental lungs of the wide world, purifying and vivifying its littoral veiny streams, for are we not rapidly acquiring knowledge of ærial currents and laws conforming thereto, and applying them to human requisites? They confessedly oxygenate and osmose the air on which man subsists, more than upon food, drink, clothing, habitation, and all the mechanical, industrial, and social arts or economics combined. But who shall be able to tell all their uses? Let us learn to love them, inspire their exhilarating ethers, expatiate in their glory and their beauty, wisely enjoy their use, honor and revere these natural types of grandeur and of glory—real and ideal; maintain their integrity unimpaired, but rather in multiplying, multiply and replenish the high places of the Pacific, and pass them on as living monuments of ancestral wisdom, from generation to generation.

KNOBBY-CONE PINE.

(*Pinus tuberculata.*)

> "Low stirrings in the leaves, before the wind,
> Wakes all the green strings of the forest lyre."
> —*Lowell.*

The Knobby Pine is a lofty tree of much beauty, from seventy-five to one hundred feet high, by three to four feet in diameter, in the northern interior of the State, chiefly in the vicinity of Mount Shasta —east, south, west, and north—and also extends along the Sierras southward. Here it forms stately trees, often uprightly branching towards the top. In general, not so flat-topped as the usual wont of pines, nor foliage tufted, and so more diffusely mantled.

On rather bald magnesian hills it sports quite another extreme; here, laden with cones one can readily reach from the ground. For the most part, along the coast hills the tree is of low growth, even broadly pyramidal in outline, shooting out relatively long widespread branches from very near the ground, so that the span often about equals the height, say ten to thirty feet, or so; six inches to a foot, or more, in diameter; bark, light brown and roughish. In some localities, of slow growth, those in richer heads of ravines indicate thrift. In the vicinity of San Francisco it seems pretty well satisfied with a humble position in the world; envies not other Nobs, nor doth it go to be promoted over the trees. The numerous rigid horizontal limbs, where it is most buffeted by fierce winds, necessarily distribute the foliage better than kindred conifers of the coast. Owing to this peculiarity, it divides and conquers the stormy winds well, and the residue is so rendered powerless for harm that it passes through chastened in its joyous journey. In this characteristic it differs from the Monterey, Bishop, and other kindred pines. This apt arrangement of limb and leafage make it more than a match for the nearly dead-level breeze that surges below, as the Signal and other like species are for the storm that plays above, where the sea-bird and the eagle soar.

The leaves are in threes, bootees half an inch or more high, the thready foliage four to six inches long, scarcely remotely saw-toothed, dull, somewhat blue-green. This lop-horned is laden throughout with roughly tubercled cones, pretty closely set, and strongly bent back. These short-horned granaries are four to six inches long, about a third as thick, in whirls of two to four or so around the branches. Several of these wheels of green cones often form on the same year's growth, require two or more years to fully ripen; color leather-brown, more darkened, faded, or bleached, or "silvered o'er with age," as they cling persistently from ten to thirty years, or for a lifetime. This cylindroid-conic fruit is moderately pointed, slightly curved, and very oblique at the base on the outside, the angled diamond-like disks of the scales, as it were, hilled up into a thick, prominent knob, prickly-pointed; seeds small, black, and slightly grooved on the sides, about one fourth of an inch long; wing about three times as long, widest at or above the middle; cotyledons, five to eight.

Found mainly on the coast ranges, from San Bernardino and Santa Lucia Mountains, to San Francisco; north, to Shasta, and along the foothills of the Sierras, Forest Hill, Forks of the American River, two thousand five hundred feet altitude, and here and there throughout the State. A chary dispenser of seed, prudently shedding out upon arid and restless sands, at long intervals, only after prolonged consecutive hot and dry days; such rarely occur only once in ten years or so.

The best shelter-pine on the coast, ever battling for its own and others' freedom, singing heroic songs to the tempest, or tuned and timed to softer lullabys, echoing the shore—anon sighing some celestial love song that "sweetly dies along the gale." The long and early buds of Spring coated, as it were, with thinned white lead are likely to attract attention and are really ornamental.

BISHOPS PINE.

(*Pinus muricata.*)

——— "the purple mountains bore
Greetings to the sunset shore—
Father guide me! day declines!
Hollow winds are in the pines."—*Hemans.*

Mostly a middle-sized pine of fifty to one hundred or more feet high, two to three feet through, bark reddish brown and rough, open and free spreading branches in due shelter, more retracted and dense when exposed. Leaves two in each sheath or boot, four to five inches long, strongly saw-toothed; the boot from being half an inch long, is at length, reduced to barely one twelfth; male flowers in short oblong or oval spikes, an inch or so long, outer and inner involving scales, six to eight, of equal length; cones set close down in clusters of three to seven, these are apt to continue closed for several years, until a long spell of hot and dry weather supervenes, say, usually, once in ten years, when they open and shed a large amount of seed. The form of these cones is obliquely egg-shaped and pointed, usually about three inches long by about two broad. At first, cinnamon color; later, chestnut brown, and in great age gray-bleached. The prickles of the scales from the tops of more or less thickened acute points, often quite elongated into straitish or incurved spurs, these becoming more swelled on the outer base when much exposed to bleak northwest winds. Seed grooved, rough, and black; wings half to three fourths of an inch long; widest above the middle.

Distinguished from the Knobby Pine by having only two leaf-straws in a boot; cones much smaller and very much shorter. They both have close persistent cones, which remain on from twenty to thirty years.

CONTORTED TAMARACK PINE.

(*Pinus* [*inops*] *contorta and var. Murrayana.*)

"A slumbrous sound, a sound that brings
The feelings of a dream."—*Longfellow.*

This pine abounds in moist inter-vales and limited plains along the whole range of the California Sierras, around north of Sacramento Valley, down to the coast within spray of the Pacific ocean; also, through Oregon, and so on to Alaska, Rocky Mountains, and Utah. It always forms the first forests of the primeval lake, multiplies around the low, ever-increasing meadow margins, and along the banks of upper alpine creeks; often covers, more or less, the seeping sides or moister slopes of mountain ranges up to about six thousand to ten thousand feet altitude. From a tree of moderate, or even small size, on the coast—say a few three to five, to thirty, forty, or sixty feet—it rises on the high Sierras to one hundred and one hundred and fifty feet high, rarely two hundred, three to five feet in diameter in some rare instances; top of all forms, but the type conic, branches slender and rather short, giving the larger forms a towering aspect with long, clean, trim trunks of clear timber, three to half a dozen saw-log lengths, or for one third to two thirds their height; bark exceedingly thin and turpentiny, especially where abraded, to which, more than other pines, it is subject; thus it is very apt to be fired on all occasions, and destroyed in great numbers. This bark has the peculiarly rippling appearance, as it were, a perfect transcript of the mirrored lake when the morning zephyr is just astir over the placid waters beside which it grows. A tree of rapid increase in little else than granitic debris of the Sierras, but from the lack of tenacity in the soil, from shallowness, and its varying states, treacherous surroundings of snow-slides, winds above, floods below, and frequent land-slides as well, changing the depth of water levels, and periodical fires, etc.—all conspire to prostrate or to kill them standing.

"How hushed and restful lies the land!
The moon-beams light the pine trees round;
Verging to friendly death they stand
And point with branches to the ground."
—*After Cornhill Mag.*

These dead trees, throughout, and those dead limbs on living trees also, are wont to curve downwards and are bowed inwards, reversing the natural order of wintergreen conifers and kindred trees, their boughs being oftener like the bow on its back. This very common condition of the dead limbs may have suggested the special name of *Contorta*, however inapplicable it may be to its natural characteristics, for this feature is too commonly observed everywhere, especially in slender sappy limbs of very many alpine forest trees, and therefore is not specific to this species at all; but, what is worse than neutral, or meaningless, is rather misleading.

A two-leafed pine, needles one and a half to two inches long, rather rigid, not very sharp-pointed, margins minutely saw-toothed, these short leaves densely cover all the smaller twigs, and remotely suggests comparison with the New England Tamarack Larch (*Larix Americana*), in a general way, as also from its swamp associations. The hue of the tree, however, is more yellowish-green; cones, elongated, egg-shape, sharp-pointed, or often rounded, especially when open, generally an inch or two in length; scales, (said to be knobby?) prickly, like *P. muricata*, and other pine cones; these may also sometimes be more thickened where most exposed to bleak winds, as we see here—a result of *habitat*—but not specific, nor varietal. On the coast the cones remain closed, and persist for many years; but what is called variety *Murrayana* (?), of the Sierras, open at maturity, scatter their seed, and fall away the same season.

Probably no timber in California ever so greatly disappointed the early railroad builders as the Tortuous Tamarack Pine—misled by a famous name or otherwise; at all events, if we remember rightly, it so decayed within two or three years as to be totally discarded, notwithstanding they had cut off and burned up all along their track far better timber, and some more lasting than the cedars of Lebanon, in serried hosts crowding to hand so very accessible.

CALIFORNIA WHITE OAK.

(*Quercus lobata.*)

"Jove's own sovereign tree."—*Virgil.*

Trees of summer-green foliage, in colder climes, contribute a large share to the thrilling joy and surprise of spring-tide—as one awakening from a sweet sleep, refreshed, with the dew of his youth upon his brow in all tranquillity—serenely embosomed in that innocent Aurora of the year, whose inmost pleasantness and peace halos at once the world and all things that are therein. Hence, as they serve so conspicuously to discriminate successive seasons, their absence is a great loss to any landscape; then, how much more so to us, who have so few grand types to boldly mark the change. Who can adequately count the value of that precious impress of innocence suggested by vernal buds and tender foliage, and all the ten thousand accessories of a well-pronounced Spring? This primeval state is the ever-blessed earthly emblem of the paradise of the ages—the year-spring, the day-spring from on high, and the Edenic origin of all worthy sentiment, the divinely innocent fountain-source of all right ideas and true growth of mind.

Of all the trees of the grove, for robust and sturdy dignity of character, nay, majestic elegance and manly pose, for freshness and for variety of expression in body and branch, twig and leaf, none excels the summer-green White Oak of the valleys and plains of the Pacific. Main trunk mostly short, five to ten feet or more in diameter; fifty to one hundred feet high, or even more; huge limbs, duly balanced and distributed, diverging at broad and varied angles from massive forks; branches with flexed elbows hither and thither, or bent and contorted in all directions; the ultimate twiggy sprays alike irregular, often only minuter mimics of their originals, yet some of the finest types, to foil this natural irregularity, crown and drape themselves throughout with pendulous branches, as we shall see; the deeply lyre-bayed leaves, lobes slender and blunt, openly notched, often again sub-lobe-toothed, downy only beneath in age; grayish-green, somewhat softer and lighter hued below. The male or stamined flowers in long pending tassels, each floret calyx with six to eight trianguloid-lance lobes, downy and eyelashed, bearing as many round anthers. Annual fruited, or setting and maturing on the new growth of the same season; the acorns very long, conical (dark color), from one and one half to two and one half inches long, usually sharp pointed, set in deeply hemispherical finely chased cups, more or less knobby or tubercled, moderately tough, horny shell, smooth within, hung from smooth, fresh green tips or twigs. The great cloud-like masses of foliage are, as it were, often in first, second, and third storied tumuloid groups, yet never towered, seldom sombre in any species, least of all in this; even the most remote approach to formality suggests no monotony, for the long, drooping branches pend archwise, like the grand and eloquent American Elm, still preserving their self-reliant ease, strength with grace, neither rough nor rigid. These elegant sprays or wreaths are seen descending down low, or lying along the ground, doubly lining the lawn, twenty to forty feet long, of nearly uniform size, like large curtain cords, somewhat simulating the Weeping Willow; but not with the despairing drop of the sad willows of Babylon; nay, rather draping robes of royalty, resting in humble repose, or reaching lowly the leading-strings—fit emblems of science applied—to lead and lift the lowliest son of earth, and though the great head be among the entanglings of the thick boughs, and his brow crowned with garlands of useful service, and there the great eagle builds her nest in the heights and gathers under her shadow, yet may the feeblest child also pillow its head on the little branchlets, beneath, light with leaf, and tenderly sheltered with shade—meanwhile the still soft voice of silence hushing to peace.

This great White Oak of the Pacific has white bark, loosely cuboid-checked, often quite rough, and similarly far extended upon the limbs, is often scattered here and there, park-like, or growing in groups on the low hills, river banks, in the valleys, and on the plains. These massive low and broad herculean colonnades often rest on the neatest lawn, sole occupants as far as the eye can reach. Relatively speaking, these oaks divide low into many huge branches, spreading as described, fifty to sixty feet each way, well balanced on the main body—with much diversity, also, do they often sweep upwards and outwards with symmetrical spreading top. The whitish-gray bark is shared by other oaks, but none have such long and slender acorns, as observed, three inches by one half to three quarters of an inch in diameter, sharply cone-pointed, nutshell thinner, smooth inside, and the tiny abortive bottle-shaped ovules sub-erect, etc. As these generations of men and oaks pass swiftly away, we hasten to record, lest self-conceiters arise upon the scene, denying observation and experience not their own; to them, neither these trees, those scenes, nor the sweetest ecstatic bliss of celestial Indian Summers, that tongues are powerless to utter or pens portray, forsooth now no more, and because they never saw, therefore never were nor could be before; "offspring of a fervid imagination;" as if Nature herself were not now and forever a thousand times more poetical than any poet, and more philosophical than any and all philosophers. Perhaps even now it is impossible to realize the extreme elegance and the wonderful wealth of foliage that characterized some of these choicest primeval and lofty types of the land. Thanks to the faithful photograph, we are not left to pen without a witness. Contemplate, then, that Napa Oak, for which we have full oft' paid the last mite for friends, and tell us if, with the Queen of Sheba, the half had been told. We repeat again, with ever increasing emphasis, our wonder at the wealth of foliage, massed above, curtained below, pouring, with unparalleled bounty, foliage on foliage, in great heaps upon the ground, as though it were not enough to canopy and cloud the sky and the horizon round about, but these sweet, fragrant, summer-green White Oaks must needs carpet the earth in softer living green beneath our feet, and luxuriously couch and pillow the pilgrim devoted to sylvan beauty. Truly, in the best sense of the expression, are these covered and floored, and so super-eminently symbolize the external and natural achievements and scientifics of life. Forth from the secluded vale behold this White Oak abroad on the fruitful plain; witness his extended wreaths flung free and far o'er the bosom of the wind, and contemplatively, who can tell the happy hearts that have swayed or swung sympathetic in these boughs, quietly, gracefully responsive to the breeze, like a floating song, anon bearing the soul aloft, serenely soaring in peace, chanting its joy to the echoing air "like music wandering o'er the boughs."

The acorns are stored by the Indian; the woodpecker and the jay make holes in the bark and drive the germinal end in for their winter food. The native stores them largely for bread—he will exchange or slight your bread for his own "pone." The acorns are hulled and prepared for cooking by a little beating and then piled on a tiny sand mound, often in size and shape of a large milkpan turned bottom up, duly leached thereon, then made into cakes and baked in the ashes. This also was the dainty dish of our forefathers, as it still is of the wild man of the wood, serves as of yore to feed his flesh and oil his sinews for the chase. They are deemed good food for domestic and wild animals, especially the hog, bear, deer, etc., but if hogs feed on them green, as cut by the impatient squirrel, they are apt to cause a kidney disease, whereby they lose the use of their hind legs and die. Toasted and ground for a coffee, they claim repute for the *king's evil*, etc., this acorn is aptest of all to prematurely germinate.

The timber is reasonably tough when young and thrifty, but becomes brittle and brashy with the infirmities of age; often late in the season when the hot sun broils and steams the sap, as it were, internally, an ax struck into it hisses like a legion of little safety valves, similar to the Post Oak of the south; and sometimes, most unaccountably, it is said to burst with a loud explosion, and strong limbs that had hitherto withstood centuries of storms, in the calm airs of late Summer and early Autumn crash unexpectedly down, the fracture disclosing not the least cause of weakness. I believe this only happens in the hotter valleys and exposures, and is never known of any evergreen oak at any season. As all great men are supposed to have their satalites, apes, and namesakes, so have the trees. Prof. Brewer and Mr. Lemmon are credited with a variety of this oak, two to six feet high—*fruticosa*, now *Q. Breweri*. By a venerable tradition of our forefathers it was deemed unlucky to cut down any celebrated tree. Evelyn says of the two men who cut down the Vicar's Oak in Surrey, England: that one lost his eye and the other broke his leg soon after. Should like to know what evil befel those godless miners who destroyed that majestic oak, over eleven feet in diameter, that gave name and renown to Big Oak Flat. One thing we do know, such irreverent and reckless disregard of God's best gift, has in potency, a wicked and heartless principle that forever tends to ill luck, could never prosper long, either in this sphere of life or that other beyond the river Styx. What marvel of multitudes, apart from man, beasts of every kind, birds of every wing, creeping or flying thing, crypt of every hue, from green and gray, dim and dark, red and blue, black or white, altogether throng the cherishing and useful oaks; and not the least of these, the busy bee that literally swarms the trees in summer and autumn to gather honey, not alone from flowers or honey dewed leaf, but mostly the bud that oozes its wine-colored nectar drops.

BLUE DOUGLAS OAK.

(*Quercus Douglasii.*)

> "Where, twisted round the barren oak,
> The Summer vine in beauty clung."
> —*Longfellow.*

This deciduous Blue Oak abounds on extensive park-like terrace-plains and foot-hills, or from coast to upwards of three thousand feet; is often rather small or only a middle sized tree, say forty to sixty, rarely seventy-five feet high; one and a half to three or four feet and more, rarely seven feet, in diameter. Let it be understood, most of our trees sport not only extremes in size, but wonderful variations of form, after their kind. These oaks, in the main, are of the low, mostly round-top old apple orchard type; and while live oaks often tend to keep up this latter illusion, this oak is only thus remotely suggestive, in the general view, at a distance; for the very white, almost white-washed bark, and pale, hazy-bluish foliage, soon disperses the charm; closely inspected, the body is seen handsomely and rather

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finely chinky, chiefly on the vertical-fissure plan, but the converging and diverging water lines are not very deep, for the bark itself is thin, nor widely gaping, like *Q. lobata*, but are more finely distributed and not so often transversely parted, consequently the bark sections not so cuboid.

These trees are usually scattered, and anon grouped, or occasionally almost groved, in nearly contiguous masses; the crooked branches are very picturesque in strong horizontal sunlight, they even show to greater advantage for the paucity of leaves; but perhaps even this is partly illusive, on account of the softened tint of sky blue, or bloomy hue. Some smaller trees of poorer white, or yellowish clay soils of our hill-sides, have brighter blue foliage, of exceeding great beauty; but such timber is a great vexation to the woodman, as it is next to impossible to split it, and when dry, with a little figure of speech, hard as iron, hence, also called, out of compliment, Iron Oak; heart, small and black, often none at all, and entire wood white. The branches of these are more horizontally spread, and of flatter top, stiff and angularly kneed; branchlets, short, often brittle-jointed, never pendent, of vagrant habit. This poor representative of the Post Oak (*Q. obtusiloba*) has a tumuloid cloud-like spray, only moderately spreading; in general, all the forms tend towards the hemispheric top; the plumed, lyred, and urned are the most graceful, varied in general forms, diversified in branch, like most of their kin, they are redeemed from formality; but the shade is too uncertain, has a hot and unrefreshing air of aridness about it that one never feels beneath the evergreen or denser deciduous oaks; the leaves, too, seem to lack character, or rather express parsimony, as they are not only scant but too much retracted in among the hairy twigs, especially is this the case in those varieties with smaller and narrower leaves; these more common forms rather suggest meagre plebian vulgarity than magnanimity; nevertheless, they adorn the landscape when viewed from afar, and go to make up a picture of much beauty. These remarks are more applicable to the sun-scorched hill and plain of late Summer and Autumn; in early Spring and Summer, when the tender buds and young leaves first put forth afresh, and all the land is one broad green carpet as far as the eye can reach, with myriads of beautiful flowers of every dye, the scene is marvelously changed, we would then fain forget and forgive those shortcomings to an abstract standard of taste, so harmoniously are they in keeping with their own surroundings; nor is this relation less by night than by day, for doth not Governor Trumbull say:

> "Now night came down, and rose full soon,
> That patroness of rogues, the moon;
> Beneath whose kind protecting ray
> Wolves, brute and human, prowl for prey."

Then these pale quirky apparitions of a lively imagination become the moon-lit ghosts that nightly stalk plains, and with rugged horns go round about the oaks, climb hills, or dimly seen evanishing down dale, nervously gesticulating their white arms aloft till the trembling stars beyond seem agitated! The bosomed owl also wakes, startling, the fiendish, sardonic laugh preluding, they, too, cry unto their fellow a ghostly, chilling cry.

This tough and close-grained timber is principally devoted to firewood, of fair quality; but on richer soils, with more moisture, and so of rapid growth, and where not too hot, it has attained some reputation in rural districts for implements of husbandry, etc.; *e. g.*, it makes good spokes and fair felloes, hubs, and axles, and for pump purposes, where great tenacity is requisite with strength and stiffness; but being so often associated with the Highland Live Oak (*Q. Wislizeni*), this latter is apt to be preferred.

This hazy-blue Douglas Ghost Oak is perhaps most of all trees laden with masses of mistletoe, *i. e.*, along the belted regions of the higher condensed, or grosser, recoiling, and more humid malarial limits, to which we have elsewhere alluded, and also more subject to diseases; better dwell down deep in the fen than upon its borders, for the lukewarm state of indeterminate stagnation is ever one of greatest danger. The foliage abounds in galls and gall-spangles of great variety, and some of brilliant beauty. The leaves have not the fragrance of the Lobe-leaf California White Oak (*Q. lobata*). The twigs and leaves in the young state are starry-hairy; stipules narrowed below and lance-formed above; leaf stems exceedingly short, outline of blade reverse-egg-form; base sharp, short-lobed, and spine-tip-toothed; the starry-velvety hairs yellowish beneath and early shedding from the upper surface, leaving it somewhat rough, and at length frequently becoming nearly smooth and bluish. On older trees leaves also oblong or oblong-oval, margins shallow-bayed, the lobes blunt, often almost obsolete; again saw-toothed, or gash-lobes inclined forwards, apex blunt, and sometimes base also. The soft blue bloom above has given rise to one of the common names, Blue Mountain Oak, but this is a misnomer, as the title "mountain," even of the third class, only rightly applies to single elevations three to four thousand feet high, rather than to collective elevations, for these properly, and by common consent, are and should be called "highlands;" hence, Blue Highland Oak is so happily suggestive of that other blue-bonneted race—realm of the rigorous virtues, the rural and the social, where poetry and song still delight to linger, loth to leave, like good Lot of old, the cities of the plain, catching the far off echoes as they journey towards serener heights,

"Where freedom wakes her mountain song."

The texture of the leaves is parchment-like, size two to four inches long, one to two broad: furthermore distinguished from *Q. Garryana* by a smaller and more slender acorn, usually in pairs, and relatively deeper cup; buds smaller, oval or nearly tiny egg-shaped, of bright brown cinnamon color, and only slightly hairy in Winter. The sparse and slender tags have the stamens set closer down, etc.

From the great liability to confound this species with Garry's Mountain White Oak, it was deemed advisable to note carefully these few particulars. This oak extends higher up the western slope of the Sierras, and is perhaps almost entirely confined to middle and northern California, from foothills to near the coast.

GOLDEN LEAF CANYON LIVE OAK.

(*Quercus Chrysolepis.*)

"Pleasant it was, when woods were green,
And winds were soft and low,
To lie amid some sylvan scene,
Where, the long drooping boughs between,
Shadows dark and sunlight sheen,
Alternate come and go."—*Longfellow.*

Complementary trees are oftener associated together in the glen with greater variety than on forest hill, broad plain, or along rich alluvial lands of streams. Trees so situated borrow some of their beauty by association and contrast. So is it with the Cañon Live Oak. But brevity demands we forego the pleasing enumeration. Suffice to say this Golden Oak of the golden State is allied to the naval Live Oak (*Q. virens*) of the southern Atlantic Coast, and is in every way its equal. As with that renowned oak, so with this, the best timber is found nearest to the sea coast; but ours of the Pacific are more secluded in habit, being chiefly confined to the steepest, nay, inaccessible, deep gorges or cañon-sides, and are seldom or never seen in bottom lands. This prefatory remark, however, applies only to the prime type, and not so much to several varieties that might be mentioned hereafter.

In general, this is usually a middle sized tree, not of high stature, say forty to sixty feet, by two to five, rarely ten feet in diameter; the main body not commonly rising high enough to cut sawlogs for ordinary long lumber, not often even in the close and crowded glen—of course, there are a few rare exceptions to any general statement, for in some gorges it has both a long body and grows to one hundred feet in height, and that near San Francisco; in those more open, the huge crooked secondary bodies and their branches bow lowly, in fact, almost kneel, full oft, resting their far elbows upon the ground. Here and there they wend along, barely above the cañon-side. They thus present a broad tented circumference of shade, rarely over one hundred to one hundred and fifty feet or so spread, the outer and lower sprays of which a man may quite overreach, and a child often step out upon the boughs or safely recline in the spacious moss-cushioned forks of the branches. The somewhat tufted spray, in dropping masses, forms a pleasing picture for the eye to rest upon, and as they often hang out freely over the precipice, produce a charming effect on the lateral perspective. The uneven outline and salient little curves only add variety and grace, and lend peculiar woodland beauty to the wild scenery.

The color of the bark corresponds to the dark glen, and becomes lighter as it is more exposed, and is more flaky and evenly chinked. As it is a matter of unusual interest to discriminate well the true type from its varieties of the same name, and from similar Live Oaks, altogether distinct, a few careful details are needful. The ever-green leaves are thick and leathery, a little oblong egg-shaped, sharp and awl-pointed, margins entire, or with rarely a few teeth; but let it be understood, on the contrary, that the leaves of young trees and suckers are prickly-toothed, like the Holly—indeed, often of the brightest shining-green, varnished, as brilliant and beautiful as an emerald, altogether unsurpassed by any known foliage of the West. Yet in age the general green becomes sobered by a delicate unpronounced riper yellowish tint, or, as in trees farther away from the coast, often with the slightest, almost invisible, twilight of gray. On old or well grown trees, when the young spring shoots put forth, they are clad with golden glands and gland-tipt jointed hairs throughout, but chiefly the lower surface of the leaves, the slightly pappillose roughened surface of the leaves like one's tongue; subsequently, if these fall away somewhat, still the scars abide, or the lingual roughness remaining, it simply bleaches out, and so changing color, becomes bluish bloom-tinted, and on hills starry-hairy. These leaves, with some latitude of variation, are usually one to three inches long by an inch or more broad; all the young parts, it should be noted, are also more or less starry-haired. The thick leathery leaves are finely netted-veined above and below, the leaf-stipules linear-lance-spatulate-pointed, often bristly-herbaceous, plumy-hairy, one fourth to one half an inch long, or usually longer than the leaf-stems to the base of which they are attached. The catkins of male blossoms are short, often branched, their calyxes (flower cups) with roundish teeth, sparsely hairy, the margins eye-lashed, stamens short, five to ten anthers on top of these threads, large, strongly cusp-pointed, cells slightly hairy. The female acorn-producing flowers, six-toothed, closely investing the embryo acorn, hairy and pimple-roughened on the back, scarcely a little scolloped on the margin; styles short, two to seven, erect; top-stigmas, broad, disc-form, emargined, or slightly notched on one side, color dark brownish purple. Acorns, solitary or in pairs, on short stems, one fourth to one half an inch long; mature acorns rarely set close down on the wood of the previous year's growth, and is what is termed a *biennial oak*, *i. e.*, they mature their fruit the following season after flowering; yet both old and young acorns are seen on the trees at the same time. The cup is scarcely hemispherical, about one third the height of the acorn, one half to three fourths of an inch across, and about one half as deep; the outer, lower, well defined scales, egg-form, acute, with brownish, thin, almost horny tips, more or less swelled below, but sometimes so overlaid with yellowish starry down as to hide their exact form; margin of the cup often thin and minutely toothed, satiny-villous within, of the six ovules in oaks only one matures; the five tiny, bottle-shaped, abortive ones of this species, are discovered on the side midway between the point and base, inside the shell; but outside the skin of the meat.*

These trees are seldom or never in groves, but scattered here and there, often widely separated, and for this reason rare, and if not timely known, are likely to become very scarce. In a general way we have already alluded to the quality of timber. The color of the heart and sap are alike white; texture exceedingly compact and tough, without any porosity of the White Oak, and far better for wine and other tight casks, etc., perhaps too heavy for many purposes, but very strong and lasting, hardens with age and due seasoning; if soaked, steamed, or treated as good timber should be, and then carefully kept a long while, to season slowly in the shade, or after being duly buried in tide or swamp mud, no timber can excel this for naval architecture, or mechanical purposes, especially where great strength and durability are required; it is claimed to be as elastic

*The fertile twigs of this and some other evergreen oaks often spend all their vital force of certain seasons in perfecting the acorns already set, and do not grow beyond it; thus the fruit may have the appearance of maturing the first year, although in fact biennial.

as the White Oak (*Q. alba*), but we have trees that excel it in this particular; does not warp and season-crack so badly as some oaks. It is almost needless to add, that where weight and crooked knees form no objection, it will be, ere long, very highly esteemed; and, as the root-knees are most of all valuable, it should only be selected and cut by the ship and wheelwright themselves; or one practiced in the art of selecting with judgment. Choice cuts of this timber are worth, at least, five dollars a foot—indeed invaluable. Let us still hope, forlorn as it may be, that by continually calling attention to this tree, as we have done, now, for more than a quarter of a century, somebody may yet be found to duly respect their own best interests and the public good. Not that we suppose for a moment that anything we could say, in one case of a thousand, would inspire a mustard seed of faith; no, nor even an angel flying in the midst of heaven, crying "Woodman, spare that tree," would suffice to stay the uplifted hand of a short-sighted greed. Nevertheless were benighted ignorance ten-fold linked to avarice, and doubly dull, will we ever cease to protest against a reckless vandalism; and though this generation "fear not God, nor regard man," other peoples may perchance cherish the choice seed and go to perpetuate the noble and supereminently useful Golden Oak, as a tree worthy to flourish when the Golden State of its nativity was no more, or only known as a watch in the night, or from the future historian, as a tale that is told. In short, this oak is far superior to White Oak in every way for spokes, axles, tongues, and reaches, bolsters, and braces, and all farming implements and machinery; the wood is often white enough, and finely compact and ivory-like for inlaying, etc.

Hitherto we have purposely avoided any particular reference to varieties, lest our attention be diverted from the main object in view, viz: that of calling special attention to the typical tree—the one best known, most eminently useful, and available for practical purposes.

The upland and open foothill form has little or no yellow fuscoid down on the leaves, but is pale bluish tinted below, and otherwise the foliage is darker, duller green, thinner canopied, but quite evenly distributed; in general outline the trees more symmetrically tent-topped, even veterans of fullest age seldom become picturesque in any decrepid sense, as they are never broken down by high winds; rarely, if ever, known to exhibit any of the venerable infirmities of age, for which reason the landscape painter might not choose them as favorites of his pencil. Seen from beneath their magnanimous spread, we behold a naked, clean, beautifully braced ærial dome, that reminds one of a vast umbrella; this results mainly from the leafage being on uniformly vigorous twigs, and mostly confined to the upper and outer surface of proximate final sprays, and to the leaves themselves, having very short stems, yet the very last twigs are not altogether unilaterally distributed, but they close up, and so cluster without any break around as to thereby thicken this relatively thin expanse; the leaves are more roundish, oftener spinous toothed; but a wonderful variety of forms must be expected; acorns larger, cylindroid-oblong, and of the most perfect symmetry of any known, just as if turned with the precision of machinery, and so closely set in the cup that the creamy white base is most distinctly marked and is rather abruptly obtuse, the flattened base having a broad areolar insertion in a shallowed cup, and this nicely clean cut, thin margined, finely chased with small tuberculoid scales below. Sap and heart-wood alike almost as white as the holly, used for inlaying. On the high peaks, inland, they often branch low and brawny; but on lower hills they tend more to the oblong type of stature, and are sometimes seen spreading archwise as they ascend and urning at the top. A few huge specimens in the Sierras have quite the typical form, and for aught we know, may prove of excellent value as ship timber; but being so remote, and the quality so little known from actual use, they must bide their own day. It is, however, well to know that the timber of all the varieties holds a good reputation. Some other equivocal varieties might be here mentioned, most of which have no size adequate to use (*Q. fulvescens*), however, is found fifty to sixty feet high, and a trunk of four feet through, but for the most part it is only a small tree, often a shrub, as in other species on this coast. Scrub apes oft come in to imitate their betters, and some tiny mimics, of only a few inches, bear acorns, as in the Ceros Island variety, in these the leaves, very small, barely half an inch long, egg heart form, abruptly horny, sharp pointed, entire or toothed, very rigid and thick, shining above but net-pitted on both sides, concave curved above or warped up at the sides, tip recurved or turned back. The slightly velvety acorns, also in pairs, on short stems one quarter to one half an inch long, silky tomentose within, scales of the cup with more elongated incurved points, and, as often seen, slightly fuscoid velvety. *Q. væccinifolia* has been deemed another variety; there are, doubtless hybrids which we must omit. Perhaps the best specimens here are seventy-five to one hundred feet high, two and one half to four feet in diameter—thirty to forty feet of clear timber on Tamalpais. From coast range to Sierra Nevada, with the Laurel, Madrona, Chestnut, Sugar Pine, and Tanbark Chestnut Oak, etc., in the coast and mountain-tempered belt referred to above Sacramento Valley to Yosemite, and below, where it is even found six to eight feet in diameter, and by "coast range" must be understood from northern to southern boundary of the State—in this latter section are found many magnificent trees, and even the smaller are complimented under the name of "Mall Oak."

FIELD LIVE OAK.

(*Quercus agrifolia.*)

"The green trees whispered low and mild;
It was a sound of joy!
They were my playmates when a child,
And rocked me in their arms so wild!
Still they looked at me and smiled
As if I were a boy."—*Longfellow.*

This robust round-topped evergreen oak of the fields, as its specific name implies, is already associated with agricultural lands, and the rural scenery of a thousand happy homes; and it is a greater joy still to know that myriads more will throng these peaceful shades as the rolling years move on, ever more and more endeared to the hearts of a people, as pleasant home associations multiply and cluster around them. Childhood, manhood, indeed all animated nature, to a great extent at least, is the resultant impress of environment. Therefore, is it no ordinary boon to be born and reared beneath grand and sturdy embowering trees—trees of wood only to some, it is sadly true—but the charmed "wild woods" to others, and to your children, with all the romance, poetry, and divine philosophy of another Eden aglow in their hearts and eyes, more hallowed than Druid ever held, or sacred than bard ever sung!

Would any, then, wantonly fall far below the barbarian's appreciation, sink in this world's forever, adown the abyss of a dark and dismal *Evernus*, over which no bird of heaven ever yet safely flew; or, perchance, instigated somewhat from that other place, go to lift up the ax against the goodly trees of house and home; let in the lonely and the dreary, the bleak or burning desert, on home-life, its intro and retrospections; slay soul, by devastating heart and desolating head, until little is left save the semblance of a man? If so, go thy way, slay the grand and noble trees, and say to the vile and imbecile shrub and bramble, "Come, thou, and rule over us." Or, rather, let us not go on always hothousing their lives and ideas of nature, in a word, narrowing down associations to puerile and artificial human perversions, or recreations, and their disorderly limitations, low, lower, and lowest, lest we "educate" (?) the image and likeness of a god into that of a snob or sentimental dunce. Trees by their presence do preëminently ennoble mankind, and though they were only one of a thousand ways and means, the wise can never afford to dispense with any available methods the Allwise Himself hath instituted, nay, ordained, so as in any, and all ways to fulfill, finish off, polish, or beautifully adorn human life, that it be duly prepared to go forth to every serious and earnest duty, even with joy and with song; run its high race of hallowed destiny rightly, and be greatly glorified!

The main body of the Field Live Oak is short—say five to fifteen feet, two to eight feet in diameter, forty to one hundred feet high, and often still greater spread—branches low, often extending nearly or quite horizontally, with many exceptions and indefinite variations, if, indeed, any general direction can be predicted of a Live Oak; it is, however, sufficiently safe, to convey a true idea of character, to say the lower masses of foliage are usually within reach from the ground; the principal limbs have the angular, zigzag, lightening lines of determined vigor and massive strength—couchant lion of the groves. This flexuosity is but the compressed spiral approaching a plane, which symbolizes while it gives the greatest power of infinite variation, yet forever retains its own essential character, has all the lesser quirks of its cogeners, nevertheless always tends, true to its type, to present roundish outline of special branch-mass, as of the entire top. The artist may rarely find one in that state of "venerable decay" so often seen among many other oaks; our Live Oaks of the greatest antiquity seem most vigorous. We have in mind, while penning this brief notice, many grand illustrative types in the vicinity of San Francisco. Around the city in various directions may be seen trees similar to those of the San Rafael reservoir—body ten to twelve feet high, eight feet in the smallest diameter; bark blackish, thick, rough, and chinky; huge well balanced branches, four to six feet in diameter, horizontally spread one hundred and twenty-eight or more feet; eighty to one hundred feet high, dividing its strength into such monster main branches that some, at the spacious first forks, a cross section of which would give you a table plank ten by fifteen feet, or more. We may not dwell at length on the quaint and manifold forms of this pastoral tree—a study of art—perhaps they are already too familiar to warrant any but the mere mock interest of novelty; but the ever varying hath in it somewhat of all beauty, the never ending variety of genuine interest, however familiar.

Some trees, like their counterpart, humanity, seek repose, shrink from the stormy strife of fierce, persistent breezes; yielding, they lean to leeward along the coast and bay margins, plains, in windy gaps, on hills and northwestern vales, wind-way records; the tops of some seem capriciously to lean off from declivities, hiding the body support like an awning, others lie prone upon the ground, or knuckle down kneeling or resting on their elbows, as grotesque as an old olive yard and nearly as human in expression; these and a thousand others might be named. Then, their natural distribution on the landscape is always an interesting study; it so often reminds you of the grouping of a vast concourse of people on some festive occasion, when, *con amore*, reposing on the lawn at the picnic grounds, the free and easy social laws of life assert themselves for tacit acquiescence, neither asking nor tolerating arbitrary human enactments, for her eternal laws are the same in leasts and lasts as in greatest and first principles, the ever unchangeable; and because they bear this highest seal of a divine philosophy, are always "charming, as is Apollo's lute."

The expression of this pastoral oak is that of calm rural repose, little or no agitation of leaf or limb, but a peculiar peaceful stillness, rest—at all times gentle, tranquil rest. As all objects in nature have their spheres, so have the oaks theirs. Few, we venture to say, can be found who have not had some experience of the exhilarating effect of the odor of oaks. This enspiriting ether is eminently characteristic of the deciduous species, although in a degree, common to all, especially is it noticeable at early dawn, and after showers. The sanitary influence of these aromas, aura-bathed, and every way breathed is to furnish the essential ethereal food of the brain and purer body, as the grosser chyle does that of the crasser body, their companionship is therefore altogether worthy the periodic pilgrimage to the sweet woods, and the primeval camp beneath the fragrant and revered ancestral oak—

> "That fills the liberal air with lavish odors—
> There, let me draw, etherial soul; there, drink reviving gales
> Profusely breathing from the spicy groves and vales of fragrance."

To dwell on all the natural objects at home among the boughs, or the parasites and epiphytes that gem this or any other oak, would be to write a volume; in a word, any one who can intelligently pass the academic oaks, is well nigh ready to graduate. In order to distinguish clearly one species of Live Oak from another, or even varieties of the self-same species, a task always more or less difficult, let us carefully note a few particulars so as first to fix the Field Oak type; then lay some stress on a strong point or so, of striking difference, and finally, apply our facts to use, the first and final end of all knowledge.

The young twigs, it will be observed, are short, hairy; the large, and larger, in a state of vigorous growth, smoothish, of dull leaden hue; the general color of foliage, dark green; leaves broadly common egg-shaped, less in size, oval, somewhat heart-shaped at base, often only obtuse; texture rigid and parchment-like, the margins shallow spinous holly-toothed as many others are; very convex above and rather smooth, becoming of a dull lightish leady hue or faded out on drying, and no finely netted veins; vaulted below, the main midrib not usually a single continuous leader from base to tip, but divides, spreading above like the tree itself, which, in some lesser sense they represent, often hairy in the forks, its stem short, etc. The loose tags of the male flowers, longer than the leaves, six to ten stamens. Female flowers with three to five long recurved styles, or recurve spreading. Acorns on young, *this* year's growth, and therefore annual (or sometimes holding over and ripening the following year, or rarely having both old and new year's together, also blooming again wholly or partially in September and November, all at one time.) Acorns solitary, in pairs, or clustered, set nearly close down on a thickened pedestal; cup obconic, or turban-like, rather deep, often purplish or beautifully rose-tinted and satiny-silky within; acorn oblong, gradually narrowing from base to top or long pointed; woolly inside the shell, little, abortive, bottle-like ovules near the top, outside the skin of the meat.

The timber is stronger than our white or black oak (*Q. lobata—Kelloggii*) and many others; the twisted fibres are so interlaced at the bifurcations, gnarled roots and elsewhere, that its strength of resistance is truly tremendous; with due preparation and care in seasoning, ranked among the best of the black oak section; of its durability less is known; as wood it does not burn like "blazes," but gives out a graduated heat well suited to domestic purposes, makes lasting coal, and the bark, the best of all slow gentle fuel. Misinformed Eastern friends record that it makes miserable timber and even poor firewood; speaking of the tough interlaced fibres *when green*; *when dry*, as the wood chopper well knows, it splits free and clean, reversing the usual order of experience in such cases. It is certainly the best kind of fuel known, save only manzanita—it even burns tolerably well green, but much better seasoned. In short, the only sound and sensible objection to be urged against it is its scarcity.

The golden west of the Pacific gives rare opportunities, if not the best, for the study of sylvan habits. Here we witness the widest range of variations in form, and the greatest extremes in size, often in very close proximity; the self same species is seen dwarfed from a lofty tree, to a few feet or even inches, each equally fruit-bearing; such observations tend greatly to disturb preconceptions, and remove prejudice, and so enlarge the area of freedom to our sylvan ideas, at least. This may be illustrated anywhere in the vicinity, and somewhat in the city limits of San Francisco; *e. g.*, this Field Live Oak in Lone Mountain—large trees two feet in diameter etc., with their spreading branches quite in contact with their dwarfs when a lee amphitheatre guards and shelters the one and exposes the other. While we must pass by unnumbered lichens, mosses, and kindred plants, it would be too great an omission not to notice a few of the most conspicuous. Of all the epiphytes that gem or grace the oaks none can be more interesting then the elegant Lace Lichen (*Ramalina Retiformis*). This festoons the branches from a few inches to several feet in length; the meshes of this lace or net work, vary from half an inch down to the finest possible little knit mits or glove-like expansions—often perfectly bewildering for multitude and for masses; color, gray verging to bluish, here and there studded with white shield plates, or tiny saucer-like discs, on which the spore-seed is ripened. Although no spell of natural oak may now capture the fair ones to dwell therein all their days together, as in legendary lore, now literally rendered—yet no fairy fingers ever wove prettier lace to while the passing hours, or hung on the outspreadings of the oaks choicer emblems of genuine interlacing scientific truths, for these are, after all, supereminently, the real interwoven garments, needle, and lace work of the soul. On half shady hill tops and wind ridges the great bat-winged Sticta (*Sticta Menziesii*) stands out from the bark half or nearly rounded, often hollowed and somewhat pitted and plaited—vaulted like an ear, studded with dark shield-like fruit. Mosses also abound, but one only must suffice—we allude to the exquisitely beautiful Golden Chenille Moss (*Hypnum Nuttallii*) in softest, closely clinging broad cushion-clad patches, the flattened feathery spray spanning abroad in long radiating lines during the wet season, fruiting earliest in winter, and during the long dry season rising, in-curving and involuting its leaves into the brightest golden chenille cords you ever saw, fit to garnish the dress or gild the crown of a queen.

This half evergreen oak sometimes partially dismantles, a portion of the leaves falling off in Winter, or becoming nearly quite bare in Spring just before the young leaves appear; others altogether retain their old leaves, without any flowers or young shoots, *i. e.*, resting over an extra season to mature and nurse the young fruit already set the previous year. This *agrifolian* oak—probably a printer's immortalized mistake for *aquifolia*, or Holly-leaf Oak (?)—extends along the coast southward through Southern California into Mexico. Some of these trees in the southern part of the State are enormous for size and horizontal spread.

CALIFORNIA BLACK OAK.

(*Quercus Kelloggii.*)

"There is a beautiful spirit breathing now
Its mellow richness on the clustered trees."
—*Longfellow.*

The finest typical Black Oak of this coast! It most reminds you of the Yellow Dyer's Quercitron, Black Oak of the East (old *Q. tinctoria*), altogether in growth of body, branch, spray, and leaf. The tree is forty to seventy-five feet high, seldom over one hundred; two to four feet in diameter, rarely over eight, only a few of them furnishing two or three saw-logs of clear lumber; in general they are too short, because when the lower limbs die—these limbs are usually short and small—they are apt to leave their dead pin-knots in, spoiling the timber, for they do not, as usual, trim themselves by a natural law, cutting off within, and by growth pushing the dead pins out, and thence righting into line the errant grain; such loose knots are apt to fall out, leaving holes in boards, etc. While speaking of the timber, it should be noted, that, like the Red Oak (*Q. rubra*), it abounds in sour sap, of which it is very retentive, and dries slowly, but if this is abstracted by soaking, or even by seasoning well, it makes excellent axles for truck wagons, buffers for cars, and for a vast number of useful purposes. Some of these trees in the higher inter-vales of the mountains, between three and four thousand feet of the most prosperous belt for this State, it often towers much like the Scarlet Oak (*Q. Coccinea*,) and the Red Oak, spreading their branches from near the middle and above, not counting the short horizontal pin-knot branches below, giving the tree an oblong outline, regularly enlarging towards the top, sweeping upwards and outwards, remotely like the elm. Many smaller forms on the exposed hills and highlands, highest and lowest are less handsome. The bark is very rough, and the blackest of all the Black Oaks. The leaves are rather a little deeply bayed by the three principal lobes on either side—a pair of lesser ones at the base—this and that side single, and end lobe, and the side lobes terminate in several sharp points weakly bristle-tipped; about four by six inches, smooth above and below; leaf-stalk one quarter to one third the length. The foliage of a cheerful middle-green, the broad candid span of the leaf has also sufficient length of slender stem for freedom of motion, which gives vivacity and sound of rustling freshness to the wooing breeze, and this in perfect harmony with the free open-hearted air of familiar access favored by relatively fewer subdivisions of the spray; this hearty expression of home-like welcome, whether decked in emerald emblems of truth, or the good of golden Autumn's yellow leaf, constitutes the peculiar charm of this oak. The above outlined description will give some general idea of this oak, a fuller will follow in the summary. Acorns solitary, or several set nearly close down, oblong cylindroid, abruptly pointed, one to one and one half inches long, about one third less broad; shell horny in texture and color, downy, set in a hemispherical cup, and usually very deep, one half inch or more wide, and deeper still; the flat, closely shingled scales, egg-lanced, rather blunt, membranaceously margined; these are usually close-pressed except where the roots reach an excess of water.

A few trees of this oak are found near the coast; up to six thousand five hundred, it is only a large bush—comes in as a tree bearing acorns at six thousand three hundred. I am assured by other observers that it grows up to seven thousand five hundred, but do not now recall any such examples. The range of this tree is from the southern boundary of the State throughout California to Eugene City, in Oregon. As Dr. C. C. Parry remarks, "there are two varieties which are only distinguishable by the fruit, which, in one, has a large and prominent gland, while in the other the gland is almost concealed by the cup, characters which seem to be constant in the same individuals."

To dwell upon the beautiful and varied surroundings of any one of the trees, would lure us too far away from the present purpose in writing. A word or so of allusion to the ordinary and most common associations must suffice, for examples are multiform.

"The character of the landscape," says the honorable and renowned observer, Humboldt, "always stands in mysterious relation to the soul of man," even in its outmost natural reflex. So, when the glory of Autumn comes down upon our landscape, as with an elfin host rejoicing their farewell thanksgiving in the gayest golden garb of the consummating year, whether in lowland dale, over highland hill, or in the great mountain valleys, what vast ecstatic settings of radiant forest gems! even the poorest, relatively barren hill-sides, become pictures of royal beauty under the magic touch of her wand. Witness the dark-green clumps of Wild Tea-Bush, bunches of brilliant scarlet berries that laden the light-green rounded *Toyon*, forecasting the good Christmas times coming, among abounding bush of blooming gray-green bosses of manzanita, young of the deeper-green Pondrous Pine, all on a ground of black or bright red soil, or the like, and everywhere round about these bright golden guardian angel oaks, holding the four winds to calm repose lest they blow on the earth and on the trees; midway the light, delicate, silvery gray Sabin Pine, casting her gauzy maiden veil over some beauty, far or near. Such is but a faint glimpse of a very little of one of ten thousand glories that dwell in the land.

Summarily recapitulating—this summer-green oak may be considered as only a middle sized tree of notoriously black bark, characteristically extending even to the main branches. The branchlets soon become smooth, leaves large, three to six inches long, broadly oval in general outline, moderately pinnatifid-lobed or broadly bayed, and these lobes outwardly tapering, like the Red Oak of the Atlantic; sometimes, again lobe-toothed and always more or less awl-pointed, in age smooth, leaf-stems slender, about an inch or so long. Catkins (male flowers-stamened), starry-downy, or smoothish; calyx, with five broad eye-lashed lobes, bearing four or five stamens. Biennial, *i. e.*, acorns set in one year and ripened the next season on the wood of the previous year's growth, one to three together, set close down, etc.

CALIFORNIA EVERGREEN CHESTNUT OAK.

(*Quercus densiflora.*)

"O spare that aged oak,
Now towering to the skies."—*Morris.*

A large tree, of great beauty and unusual regularity of outline, being broadly conic, often oblong-conic topped, and always, if in freedom, the most symmetrical of any oak ever seen. The very wide range in the size of this dense-flowered Evergreen Chestnut Oak is scarcely less wonderful than is seen in its boon companion, our Evergreen Chestnut itself, being from a few inches, or feet, to one hundred and fifty feet high, and to six feet or more in diameter. Throughout the Coast Range associated with redwood forests, or chiefly bordering their vanishing limit, among such colossal trees it must needs aspire with more or less erect-spreading branches, and here is often seen the somewhat spire-shaped top; but with space to spread, the lower and middle branches reach abroad horizontally in the flat fan-sprayed type of the very large Pacific Red Alder (*Alnus rubra*), but so perfect in form that no possible art-training could equal it for true symmetry; the ever verdant leaves are large, like the chestnut, two to five inches long, one to two broad, leathery, oblong-oval, lance-pointed, rather abruptly acute, or the smaller forms somewhat sharper pointed, base more or less blunt, feathery veins parallel, margins saw-toothed, rarely altogether entire, save at the base, edges slightly turned back, underneath remaining more or less whitish, and at length tawny-woolly, like the twigs and leaf-stems, although above becoming nearly naked and smooth. This close-set ample foliage so abounds as to render the shade the densest of all oaken shades, and yet airy withal; this is owing, as just suggested, to the rectangular level spread of its numerous limbs and leaves; this peculiar disposition of branch and spray also gives it a seeming openness and freedom, not altogether warranted by the very short, stout, and almost rigid leaf-stem and the nearly impassive blade. The color of the foliage of this tan-bark Chestnut Oak is rather a pale, quiet, subdued green; the conspicuous young twigs and leaves first appear as if clad in a cloak of the finest lamb's-wool imaginable. The illusive appearance is like that of beholding a large tree in bloom; the real blooms, however, are like those of a chestnut, *i. e.*, in long clustered erect aments, or tags, of a creamy white color, densely studded with flowers, myriads of long stamen threads standing out all around like fairy pins stuck in the tag tails. Acorns, one to three or more together, set just below these bundles of tags, ripening the next year thereafter; the cup is often somewhat hemispheric, or flattish, very shallow, and wheel-shaped; scales uniformly loose, rounded coarse-thread-like tips, weakly curved or often bent back, soft and velvety, in short, mossy; the acorn-nut large, oblong-cylindroid, or remotely egg-form, abruptly or broadly pointed, satiny outside and inside of the horny shell, and also inside the mossy cup; color umber, or light brown, a biennial oak, with the clustered fruit on short stems.

As this oak largely marshals among redwoods, cypresses, spruces, and firs, it evidently delights in humid half shady woods and fog-bound coasts; but the finest types we have ever seen are along a region from fifty to one hundred miles or more north of San Francisco, in that coast belt where the fog line vanishes as it greets the dry air of the interior valleys, as *e. g.*, Russian River Valley, and the Sacramento north. Nevertheless it migrates far away from fogs, and even occasionally ascends the Sierras to about three thousand five hundred feet altitude, and extends inland to Mount Shasta and the vicinity of Yosemite Valley, here they seldom exceed a foot or two in diameter, are oftener even only tiny fruit-bearing bushes. The bark, though not altogether smooth, is rather even, and lighter colored than the chestnut, or grayish-brown, the sharp and deep irregular chinks not much disturbing the surface, except in great age. The wood is straight-grained, rather soft and brash, too porous for staves, except for dry use; great or high artificial heat wonderfully toughens this timber, but if left to itself, when cut in the sap, in the long days of June and July, and the four-foot jacketed pieces of bark peeled off for tanning, then it decays in four to six years. Like the redwood it sprouts up vigorously, and rallies from the stump to repair or reinstate the forest in the wake of the fire or the ax, as well as the best. These pieces of bark spread on their back exposed to the sun soon coil or quill and dry up, are corded and shipped. The general forms, with a few details, have been already dwelt upon, but still among so many uses and beauties it seems a pity to pass unnoticed one of the chief charms of the California Chestnut Oak, lest, freezing the genial current of the soul, her song-birds seek other climes—we allude to the softened lights and shadows that follow with the bending and upturning foliage moved by the wind—a soothing sight eminently tranquillizing the mind, with naught of the grand flash, nor the restless rustle of petty individual leaves furtively vacillating on their own account, but noble, quiet, unanimous masses, moving obedient to becoming grace and dignity. These apparently ever-vernal oaks have also their successive seasons of leafage, Spring, Summer, and Autumn, similar to deciduous trees; they too, cast off those antiquated and verdant emblems of transient truths, for such leaves have already subserved their day and use, so do they return again into their rest, their Winter vigil, though it be less hearty, even less profound than their totally dismantled kindred.

The oak, like the vine, lingers longer in the lap of the mother than most other trees, tardily the buds expand, coyly the tender leaves open their wings to the warm sun; precocity here, as elsewhere, would be no index to final strength nor to lasting vigor. Striking contrasts are less manifest in most monotonous evergreens than in this species, and therefore yield less heightened pleasure in their contemplation.

Most acorns, in their bitter state, are apt to prove injurious to stock. Fortunately, when such fruit first falls, few animals, save bear, hog, and deer, eat them sparingly, and not even hogs, with impunity; but later on they sweeten and are freely eaten even by cattle, beast, and bird. Continuous rains and melting snows abstract the soluble bitter and injurious principles and leave the farinaceous or starchy—in some cases incipient germination supervenes and sugar is developed; other appetizing changes take place. The Indian leaches his in tiny sand cups or on mounds made for the purpose, or he places his buckeyes, acorns, or any nauseous nuts, in little streamlets, if rains be scant or too tardy. The jay and the woodpecker make shallow conic holes in the bark of trees, driving in strongly the sharp end to prevent the germ from swelling, and so ultimately sprouting, to his or their loss. The water lines are rain guides that soak and lave the porous base, and so prepare their Winter stores for use as well. The bee sucks honey from the buds, leaves, and cups as well as the flowers.

Many thousands of acres of this tan-bark Chestnut Oak, as it is often called, are annually doomed to wasteful destruction by a well known perversion of the land-locating law. "Frame houses"—forgive the scandal—or are they only the disordered phantoms of dreaming madmen? Four posts, or poles, trans-rails, no roof, no door, no window, no floor! These are the ghosts of houses that confront you at every turn along the coast, and serve to hold one hundred and sixty or more acres of land—*i. e.*, stool-pigeon timber claims, or land, timber, bark, and all. Dismantled of timber, bark stripped off, etc., then the "claim" is lifted for another, and so on *ad infinitum*, or until waste and devastation mark their path, with none to stay the wanton destroyer. Were the valuable timber utilized in any way, even by portable mills for staves or the like, there would be more apology to offer in the sight of God and man. Cut in the sap, prone on the damp ground, in five to eight years they utterly decay. They would certainly make dry barrels, and such boxes as communicate no disagreeable taste or odor to their contents. In some instances its timber has proven a marvel of toughness and elasticity. Well chosen and thoroughly prepared, it makes good felloes.

May their perfect shadows never be less; shadows never damp and chilly, as some we wot of, but pleasantly warm and dry. We have before alluded to oaken odors as eminently salubrious, and when their shadows also are of the beneficent and safely refreshing sort, like this, they commend themselves to the ruralist from all points of view. Better breathe the health-inspiring odor of the old open tanyard itself, than the close consumptive airs "where people most do congregate." Together with the wide range of this evergreen oak, let us keep constantly in mind the fact, as eminently peculiar to California trees in general, from being one to two hundred feet high, they may and do dwindle down to barely tiny bushes in full bearing, aping their betters, though old enough to have lost all their teeth, and still the leaves rigid, thick, and varnished, as near the north and northwest base of Mount Shasta, at Soda Springs, as Hon. B. B. Redding's recent specimens fully show. The incalculable use of its leaves as food for silkworms, of oak-eating species, will be further alluded to elsewhere.

GARRY'S PACIFIC POST OAK.

(*Quercus Garryana.*)

"What if my leaves are falling like its own."—*Shelley.*

This White Highland Post Oak bears some resemblance to the Long-acorn, or Weeping White Oak (*Q. lobata*), although, for the most part, a smaller tree, of less majesty, and altogether more of the old orchard-like habit; there are, however, a few grand types in the interior of the State—Grass Valley and elsewhere, Vancouver's Island, where we observed and collected it, through Oregon as high as The Dalles, and south along both coast and Sierras to San Francisco, in size ranging from thirty to one hundred feet or more, and two to eight feet in diameter. This oak has the highest northern range of any; here it could hardly be considered a "mountain oak," for its altitude is below four thousand feet, although sometimes so designated; so far as we know its belted limits only extend from coast to foothill, preferring highlands, and leaving, for the most part at least, alluvial bottoms in the possession of the grander and more graceful *lobata.* It is well to bear in mind that trees, shrubs, and plants in general, observe certain lines of common average temperature, technically termed "isothermal lines;" these belts, or lines, are here and there slightly modified by exposures, arborescently speaking, west and northwest, especially with underlying ancient morain, being most of all favorable for trees; besides, altitude as we approach the great Sierra Range, becomes more important, because with similar soils every hundred feet of elevation gives about an inch more average rainfall; the roots also go down sixty to one hundred feet or so, often intercepting much underground drainage from never failing spring supplies, fresh from their alps or subterranean reservoirs; while at the same time there is less likelihood of killing frosts, the atmosphere being drier and relative radiation less. The Garryana Post Oak is probably the least strictly observant of this common law, having, as we have seen, an unusually wide range. Now, the practical import, use, and hence inferences from such data are, that where oaks and other forests flourish on even apparently poor and esteemed inferior soils, of neglected—too often discarded—foothills and highlands, all civilized experience, in Europe, America, and elsewhere, has invariably shown them to be surprisingly fertile and very lasting lands—lands most eminently suitable for orchards, vineyards, olive yards, gardens, and for the most varied and useful culture. Few suggestive allusions must suffice, as they are deemed more apropos to a general treatise than to any one sylvan object; we therefore forbear the thousand local examples that could be cited in proof or illustration from Georgia, Alabama, Texas, California, and all virgin soils, with various reasons that might be given at length.

This Pacific Post Oak reminds us most of the best types of the Eastern Atlantic Post Oak (*Q. obtusiloba*). More even than the Blue Douglas White Oak (*Q. Douglasii*), or any other on the Pacific Coast.

This great arborescent dome, ninety to one hundred feet high, is convoluted into a magnificently spreading top scarcely less grand, if not so graceful, as its pendent rival. The trunk, five to eight feet through, has the bark finely chinked, and frequently transversely cuboid-cracked, in hotter localities. Indeed, there is nothing at all meagre in the Northern, Oregon, or best California forms. The expression and general bearing of the tree may be said to be manly, free, open, and generous-like. True, many of ours are less imposing, being commonly of lower stature, and more disposed to spread abroad. The leaves are large, broader at the end, or reverse egg-form in general outline, but deeply bayed, sometimes cleft-like bayed, never bluish gray beneath, like *Q. lobata*, but the under side, leaf stem, young branches, and long sharp-pointed Winter buds are all clothed with a dense dingy brownish or dirty yellowish starry down, scarcely a little of it seen on the upper side of the leaf; unequal lobes, mostly blunt and short, weakly prickly-pointed; slender tags, slightly soft-hairy; barrel-shaped acorns, in some forms more oblong, often in very shallow cups set close down on the twigs; scales of the cup egg-form at base, with elongated tips, soft-hairy, dense, close pressed; the color of the acorn light yellowish. This Garryan Oak can always be readily distinguished by its rather large, variously, but commonly deeply lobed, thick leathery leaves, and very short fuzzy, downy coating beneath, and by its large—one fourth inch long, or so—sharp woolly Winter buds. As Dr. Englemann properly remarks, one form of *Q. Breweri* much resembles this Highland White Oak, but the strong point of distinction most worthy of note is omitted in the description, viz: the acorns of Brewer's Oak, one to seven spicate, or set up on a single stem from one half to two inches long. This feature is best observed in the young state.

The wood is excellent timber, valuable for ship-building, wagon work, and for a vast variety of useful purposes. The northern forms, and those not too much exposed in dry and burning localities, yield the best timber in size and quality; have darker colored acorns and more elongated, egg-form, or more cylindroid, *i. e.*, relatively narrower girth, sharper, or not so abruptly pointed, and covered with weak hairs; ours, absolutely smooth; the tree also is more angular, besides the bark of the northern tree is not so very white, is more even, though never smooth. As a general rule, the younger and more thrifty timber bears the best reputation; used for wagon purposes and other rural requisites.

Although the actual Philemons, hamadryads, and, indeed, the oracular oaks themselves are gone, and no nightly torch-pomp, nor Druid priest lead the way to the Mistletoe, (*Phoradendron flavescens*) yet we do well still to heed it, for where it marshals its hosts on the trees, the fen-sucked fogs are stayed, boldly marking the limit of malarial lines, and chilling damps of nightly gloom, with their untimely frosts; this invisible dragon of the abyss often wends his way farther up the ravine, often abroad on the contiguous plain, but the sacred sanitary sentinel hath its brazen tent pitched high aloft in the trees, and he dare not pass; but it gives place to the pure and more genial airs above. Under similar conditions, in like localities, the mistletoe also greatly abounds on the Blue Douglas Oak as well as upon this Garryan Pacific Post Oak.

It extends from San Francisco Bay north to Vancouver's Island, mainly on the sea coast, but occasionally passes around above the head waters of the Sacramento River to the Sierras.

BUTTON-BUSH TREE—RIVER BALL-FLOWER TREE.

(*Cephalanthus occidentalis.*)

A beautiful symmetrical well balanced tree, forty feet or more in height, by one to two feet in diameter, along such rivers as the San Joaquin, or such lesser streams as those of Lake County; the best types with a straight body fifteen feet or so, the upper third crowned by a handsome rounded or semi-rounded head, probably some few of these exceed forty feet in height, by a foot and a half in diameter.*

* These proportions, we are well aware, will strike with some surprise those familiar with the Button-Bush as a small shrub elsewhere, for which reason, a word of general remark becomes necessary. Even the scientific visitor is too prone to consider such extremes as distinct species or varieties, being quite unaccustomed to this wide range of development. We might cite numerous familiar examples—might almost say rules—among the oak, chestnut, cypress, spruce, pine, and bay, etc., besides bushes, herbs, and so on. It is not easily reconcilable with our preconceived ideas of propriety for a wintergreen chestnut (*castanopsis*), to bear fruit a foot or so high, and then see it seven or eight feet in diameter, huge trunk of clean colossal column seventy to eighty feet, thence towering one hundred and fifty feet high; nor an evergreen Tan-bark Chestnut Oak (*Q. densiflora*), one hundred and fifty feet high, and nearly of equal spread, sound, and ramping in the vigor of youth—on the coast—and then find it in full fruitage a few inches to a foot high, among the least of shrubs, near the foot of Mount Shasta; nor a cypress (*C. macrocarpa*) and others, four to six feet in diameter, and only a little way off, in equal fruit, barely two or three feet high; or the Tamarack contorted pine and others sporting in the same way; the Buckeye, or Horse-chestnut exhibiting similar extremes. Think of the California Bay-tree fruiting, a common bush, then furnishing hewn logs seventy-five to one hundred feet or more, tapering from three to four feet to a foot, and others eight feet through, and straight as a line (exhibited at Mechanic's Fair), seen for a thousandth time on coast or mountains only as a respectable shrub, waving elders, etc.

Take another example, to wit: our tiniest of Buckthorns (*Rhamnus croceus*), mostly a lowly matted shrubling, when flowering and fruiting, the body scarcely the size, nay, often half the size of the quill you write with, yet occasionally a small tree, body half a foot or more in diameter, and that higher than one can reach, and the ample top fifteen to twenty-five feet high; wood as bright yellow or brighter than the boxwood of the engraver, texture of exquisite homogeneity, susceptible of the highest polish for cabinet and fancy work, or useful withal; abounding in crystals of oxalate of lime, makes the choicest strops or hones to sharpen, but otherwise bad on tools, and eminently so on the ax. Again, one most

The Button-bush, along slow creeks, margins of swamps, ponds, rivulets, and springs, may not be more than eight to fifteen feet high in many places. But the River Ball-flower Tree, in all its greatness and glory, all over aglow in white and creamy button-balls of flowers, crowded into little globes of an inch or more in size; the long pistils like insect pins, innumerable for multitude, sticking out all over them; in this spherical head, each tiny floweret is forced into a wedged, four-sided, inverted pyramid; but details apart, they are fragrant as the honey hive itself, and fairly alive with bee, insect, and butterfly life; besides being the fond retreat of the humming-bird, and unnumbered songsters that throng their boughs; often a grand and glorious ornament to riversides and watery regions, from June to Autumn; the joy of the sportsman and the admiration of the foreign traveler, from its singular mode of flowering, and by its flowers appearing at a season when few others are to be seen. These are the natural liveried attendants that graciously blandish their charms before us, while they serve to introduce us to the living fountains that spring high up among the mountains, or rivulets that run among the hills, or meander the hotter intervales, that loiter more leisurely still through fruitful vales, along lowland leas, to tranquil bay, or to the great peaceful ocean itself.

The branches often shoot straight up from large trunks borne down by floods forming a kind of secondary deformed tree, but in the broader, stiller waters of larger streams, the erect sound body is every way perfect, and the branches spread gracefully, arching outwards into the most regular forms of beauty. On recent shoots the bark is a live-green to reddish bronzy, with a few brown dots, in age becoming lighter or clay-gray; the body-bark splits and spreads into cracky, rough diverging fissure-spaces, frequently covered with mosses and lichens. The shoots are tough and pliable notwithstanding the large pith, yet the older wood is soft, light, and brittle. The leaves opposite, in whirls of three or four, broadly-oval or lance-like, or oblong-egg shaped, very entire, acute base, and sharply-lance-pointed, smoothish shining-green above, lighter netted and downy on the veins beneath; texture rather tough and leathery, three to five inches long, about two broad; the leaf-stems half to one inch long, stipules leave their scars between the insertions above.

To note the flowers more fully, the globular heads on round stalks one to three inches long, from the axils of leaves, in terminal sevens apparently, but really in whirls of twos, threes, and fours, just like the leaves; tiny calyx, short, green, tubular, silky-hairy, four-sided, and ends in four lobes or rounded teeth. Slender, almost

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familiar with the herculean *Pinus ponderosa*, the grave *Jeffreyi* form or species (?), would be the last to suspect it of sporting on the shallow shore of similar extremes, but in Owen's Valley, at Casa Diablo Hot Springs, it is little higher than one's head, where we reached up from the ground and plucked the cones, and yet a few yards off, at exactly the same level, were trees one hundred feet high. Similar remarks apply to *P. Torreyana*, etc.—on the contrary, it is just what we are prepared to expect of *P. tuberculata*, because so familiar with groves of it laden with cones, only a few feet high, on white magnesian hills; a little larger on the wind-buffeted coasts, but near Mount Shasta, east, southwest, and north, one hundred feet high, quite reversing the habit of the Tanbark Chestnut Oak above referred to. Truly, conditions must be very congenial or otherwise—say variable—to produce these surprising contrasts, not a tithe of which can be enumerated. Our excuse for this general note of even these, if any were needed, is seen in the absolute necessity for due allowance being made respective observers and the writer, as well as for climatic and other environment, and for these reasons we see plainly why absolute measurements appear to be of so little value.

thready, flower-tube twice as long as the calyx, the four rounded teeth segments tipped black; threads of the four anthers attached to the throat. Seeds similar to sycamore.

From the Cinchona or Peruvian bark alliance of this Pond Dogwood, as it has also been named, it would be reasonable to expect the bark, especially of the root, would cure fever and ague, it is accordingly celebrated for this purpose; and, also as a valuable bitter tonic for obstinate coughs, and in the treatment of external sores, etc. Flourishes well around springs and in good garden soils freely watered, of course; a fine ornamental shrub, of celebrity abroad, where it is prized in the green-house.

GOLDEN-LEAF CHESTNUT.

(*Castanopsis chrysophylla.*)

"Timber of chestnut and elm and oak,
And scattered here and there with these
The knarred and crooked cedar knees."
—"*Building the Ship*," *of Longfellow.*

In any other country than California, the truly colossal character of the best types of this great evergreen tree would excite astonishment. One hundred to one hundred and fifty feet or more high, five to nearly ten feet in diameter, forty to eighty feet clean trim trunk, and very little taper—for at length in age it becomes massive and towering, like sequoian cypresses—bark more brown, with scarcely a visible tinge of gray, the chestnut-creased channels of it sweeping down like a vast fluted Corinthian column, with only enough water-line divergence to break monotony, bar out the formal and bring to its aid the varied and cheerful. The tone of the tree in general is always dignified and elegant, or grave and venerable—crowned with a wealth of noble, laurel-like leaves, top coned, oblong, or domed in an ever living, rich and royal mantle, golden-lined. This tree may yet, ere long, meet the eye of art—pen or pencil, rural or arboreal, for there are many gems of the *genus homo* abroad in this land, it is a pleasure still to know, who have the harp-strings of their hearts already attuned to joyous impress, when Sylva blandishes her beauty before the foot-lights of nature's grand oratorio, anon chaunting worthy songs to their sense. With such congenial companions of the wood, let us wander and view together this lofty Chestnut o'er the landscape gleaming! May it be a morning without clouds, when the early sun, from his golden urn orients the east, and, rising from his rosy pillow, greets a radiant morn. For where else in the wide world can we inquire so well how the noble Golden-Leaf Chestnut returns the glad salutation from mountain or hill-top, on landscape or lawn, as of the vivid and veritable witnesses of that thrice sacred Delphic shrine of one's own experiences.

As the suggestive specific name implies, it is derived from the common observation that this foliage, when stirred by the zephyr, rolled by rising winds, or lifted by the stronger breeze, turns the golden under surface to the sun, reflecting a softened sheen of rich orange-yellow, strikingly contrasting the general ivy-green, and lighting up the face of its foliage with a cheerful smile. Besides these transient moods of sympathy with passing events, it hath, moreover, later on in the season, more abiding features: when the tender shoots and young leaves put themselves forth, they appear clad in yellow down of the cygnet, or in golden velvet; these hold the attention effectually and steadily to its true characteristic expression. This latter quality, seen from a distance, awakes a charming illusion, as if the beholder were reviewing a magnificent evergreen tree clad in golden bloom.

Another forest tree, alike illusive to the distant eye, occurs to mind; we allude to the dense-flowered Chestnut, or Tanbark Oak (*Q. densiflora*). A similar large sylvan companion of *castanopsis*, and for the most part the typical tree, is found among redwoods, or near by, and in similarly tempered belts of coast or moderate mountain ranges. These young twiggy tufts are of an almost pure velvety white, against a lighter and duller green background. This, like the chestnut, is a choice landscape ornament, simulating it in general symmetrical outline, although the oak is of somewhat more open and spreading habit, and especially so in isolated trees of open grounds; is also an evergreen, and claims close botanical alliance with the chestnut; but the leaves are toothed on the margins, and has the large, well-known acorn with mossy cup, whereas this tree of which we treat bears a prickly chestnut burr, with rather hard, brittly-shelled, sub-triangular sweet nuts, about the size, texture, and quality of the common hazel. But to return from this parallel digression, deemed advisable by way of contrast, and because so many are apt to confound these two very distinct trees, thus leading to confusion and, as we have known, to controversy.

Whenever brought into cultivation this will make a magnificent ornamental shade and shelter tree for certain fog line localities of the State, and for foreign climes of similar requirements. Besides, for valuable timber it should be observed that the wood splits straight, and about as readily as its eastern relatives, is nearly as soft and easy to work in the recent state, yet becomes very hard when dry from age or proper seasoning, such as soaking, boiling, steaming, etc. As seasoned stuff it planes and polishes remarkably smooth, is glossy, lightly yellowish or golden tinted when varnished, and valuable for cabinet work; it is also found to be very tough and elastic, and therefore highly prized by the wheelwright, shipbuilder, and for many mechanical purposes.

The ripe fruit, which sets the preceding year, appears simultaneously with the flowers, from August to September; catkins strictly upright, one to three or four inches long at the extremity of the twigs; leaves seven to eight inches long by one and a half inches wide, dark green above, golden yellow, densely scurfy beneath; margin entire, thick, and leathery; burr horrent, with divergently radiating spines, from murex-like prominences; nut subtrianguloid, shell hard like the hazel and about the common size, but rather more pointed.

The *Var. Minor*, a Chinquapin form of bush, bearing fruit, from one to six feet high. By the way, this native or aboriginal name is of curious and very suggestive origin. Indian traditions say it was derived from some shipwrecked (Chinese?) Asiatics, who, on seeing and recognizing these American shrubs as like their own species, called them "Shin-Ching-Kang," corrupted "Chinquapin." We have seen this Asiatic species, and a similar one to our "Chinquapin

Oak" (*Q. Chinquapin Mx.*), the former a true castanopsis; also a larger oak quite similar to our common *densiflora*, and of like use—*i. e.*, for the food of their invaluable quercophagus silkworm (*Saturnia cynalina*), formerly known as a bombyx, the silk export of which amounts to over sixty millions of dollars a year, and only raising two crops a year in China, whereas in California we could raise at least five, without any artificial heat and far less care, and even that, simply the light labor of women and children only, thereby more than doubling the annual income of every farmer, ruralist, or laborer in the land. Also feeds greedily upon *Ailantus glandulosa*, or Tree of Heaven, etc., besides the mulberries, the Japanese being the best.

MADRONA TREE.

(*Arbutus Menziesii.*)

"Before thee stands this fair Hesperides
With golden fruit."—*Pericles; act first, scene first.*

Who will solve for us that most marvelous sylvan mystery of the Pacific coast? We allude to the almost universal neglect of the magnificent evergreen, Madrona, the finest ornamental forest tree of the continent, unsurpassed for grandeur and varied beauty. Let us consider its just claims for a moment. We have at our bidding a lofty tree fifty to one hundred and twenty or one hundred and thirty feet in height, four to eight feet in the smallest diameter, and some few over ten feet, often with huge limbs two to four feet through, horizontal spread of at least seventy-five to one hundred feet, and at either the main forks or kneed base, transverse sections would give us solid planks of ten to twelve, or even fifteen, feet, suited to rival old King Arthur's round table of world renown. So might these memories pass along to future ages afar, commemorating a noble race of forest trees, swiftly passing away, condemned to the rural *hades* of our homes—their moloch fires, or the funeral piles of our fields—a burning shame to this foolish, wanton, and wicked generation. Blessed oblivion, draw thy darkest mantle o'er this page of our early history! But if no such boon is vouchsafed us, let us alone, for we will turn our backs upon the vandals, lest we seem to countenance the accursed manslaughter, and be arraigned before the bar of future judgment as in some sense accessory. Come, then, and we will consider it together, as it stands unmolested in the paradise of its delight, fresh from the hand of the Great Creator. Seen in native haunts, on alluvial lands of the coast, or amid other forest trees, we behold it straight and trim as the most fastidious could wish; when young, easily domesticated, trimmed, and trained to any form desirable; later on in life, broad, massive, grand, and supremely picturesque; at home on foggy coasts, with fierce winds, yet preferring due shelter, rejoicing on dry hillsides where fogs vanish and the soil becomes relatively barren; and even on burning peaks, ever clad in rich foliage of living green, equal to the most majestic magnolia. Other trees may sleep in quiet, waiting the return of the wild song bird and the renewing breath of Spring, but love's highest emblems never sleep; ever on the alert, she is awake with the new year, bringing gifts to the dear ones and good to all living. Laden with shagreened orange and red berries, the most beautiful the eye ever beheld, surpassing the choicest strawberries, sweet, nutty, and delicious to the taste, she sub-tropically overlaps the rolling year with ceaseless glory. Anon, the sweet breath of her flowers, now in bloom—April and May—greet the sense, fragrant and exhilarating as odors wafted from the happy isles; busy bees, emblems of untiring industry and its natural delight, literally swarm these nectared urns, with butterfly, and flying thing of every wing, a countless host that phone their ecstasy to the listening flowers all the livelong sunny hours.

> "Nor undelightful is the ceaseless hum
> To him, who, musing, walks at noon."

These white and blushing blooms peep over the dark green background crowding their clusters into view, or bashful and half concealed the whiter and purer bells hide beneath the shade. It is thus she modestly droops her pretty heath-like clusters, cheering the vernal months. How neat at all seasons! changing her dress as custom requires—yet always elegant, caressing the eye, ever suing for admirers, exfoliating bark, or laying off a few superfluous leaves in the hot months of July and August, the most strikingly picturesque tree of all the groves! Limbs now out fresh, smooth, and soft as an African's skin—yea, with the most exquisitely freshened green, tender, and delicate as any maiden's, fair tablets to carve "Rosalind" upon; the very sight of which is like inspiring a sweet zephyr, just astir, breezing from out some cool shady grove, when the traveler is faint and weary. Even the fading foliage falls unobtrusively down, as comes "still evening on" in twilight dews. Fading foliage! did I say? Nay! the beautiful leaves brighten like celestial hopes above into every shade to hallowed gold and royal purple in exchange for the natural green of earth. So also the sea-green surface beneath, yields to a softened mellow-white, no artist could cease to admire. With such a sheen the enlivening shade, is by far, the most cheerful that ever bore that name before; myriads of bright and gay reflectors spiriting it away; meanwhile, shedding "their sweetness on the desert air." Our feet never pressed her half-dismantled robe without a feeling akin to entering the neatest ladies' parlor in the land. Instinct with the feelings of the great chief, we are fain to echo the eloquent apostrophe * * * "the earth is my mother, I will repose on her bosom!" With uncovered head and due reverence in the presence of orderly nature, we are oft' prone to tarry beneath the beautiful boughs; and may we say it—always leave with the lingering regrets of a lover. Returning anon! behold the pea or sky-green bark changed to deep orange, burning red, or sober cinnamon brown, out of due respect to autumn, and the fashion of the season. How strange the view! What marvel of moods! Fascinating by every art that could please with ever-varying beauty; could imagination, fiction, or fancy portray to itself a sylvan object more wonderful, more chaste, or more charming?

Why then, it may be asked, are so few of our surface artists found who give adequate prominence to this marvelous middle and foreground tree? Yet how exceedingly apropos to their purpose, and so characteristic, too, of Pacific scenery. Yea, altogether lovely on the landscape, faultness in form every way—in the bold bossed, kneed base, sturdy body, rivaling the oak—huge branch and strong arm; full of native character and never formal. Ah, me! again, what bark—warranting the highest warm coloring, without the least exaggeration—and such leaf, flower, fruit. Time would fail to note its varied expression, and even to old age and forever, beautifully picturesque. Panoramic details apart, consider it again in one view, that it sink deep into thy soul: Broad magnanimous canopy of large, thick, rich shining or varnished-green and tropical foliage, vivid semblance of the Grand Magnolia (*Magnolia grandiflora*) of the South, laden, as it were, with a mass of burning berries; seen in due season, such smooth, red, naked limbs, gleaming from out the opening mantle like the native red man—giant of the wood—stalking the forest with majestic tread, and you have before you the handsomest tree of the far west. Like exfoliating trees in general, which have their wood of continuous texture, with little or no separation of porous structure alternating with annual rings of growth, and so are never "shaky" nor liable to split, this timber has a high reputation for furniture—polishes, stains, and works well. But spare us, dear reader, the further merited allusion to its timber. Ghosts of departed sawmills and vandal skeletons, with ax in hand, loom up from "that other place" to haunt the evening of our days. We would rather sit on Madrona's knees, that resemble those of the deciduous or Bald Cypress (*Taxodium distichum*) of the East, and teach your children the wisdom that shall reverence sylvan use and beauty, that they may offer, betimes, some acceptable incense of affection for the native forest trees of the land.

True, this tree, like others we could name, does not bear transplanting from the wild state well, from lack of the usual number of fibrous roots of many other trees, but it germinates easily and grows freely from the seed. "Why, then, is it not more cultivated?" Nurserymen justly reply: "Because there is no demand." These, and other tree seed, should be put on the ground so soon as possible after the first rains, and nursed and sheltered from the sun.

Dr. H. Behr presented to the California Academy of Sciences, some years ago, a peculiar web, sent to him from Arizona by Baron Koels; these webs were the product of a caterpillar of a butterfly (probably *Eucheira socialis*), which feeds on this *Arbutus Menziesii* during the rainy season, and protects itself in these webs against storms and other inclemencies of the weather. As these webs are impervious to water in the liquid form, but let it pass through in the state of vapor of perspiration, they would furnish water-proof clothing without accumulating the perspiration like prepared silks, rubber goods, etc.—and, withal, exceedingly light and elegant. The cultivation of the insect would develop a valuable article of export, amounting to millions annually.

EVERGREEN HUCKLEBERRY.

(*Vaccimum ovatum.*)

"How calmly sinks the parting sun! Yet twilight lingers still;
And beautiful as dreams of heaven, it slumbers on the hill."—*Prentice.*

Of all the formal symmetrical beauties of the Pacific coast, none exceeds the Evergreen Huckleberry bush; but why is it that these native beauties never fail to strike the stranger with admiration, while the average Californian is so seemingly indifferent? Familiarity can scarcely be pleaded, since few are able to recall them at all, perhaps being more devoted to a tour of mountain observation, may account for it, as in other respects we are not inferior to them in appreciation. This shrub is usually five to ten feet high, mostly with numerous spreading branches and hairy branchlets; leaves thick and leathery, smooth, dark green, shining, somewhat egg-shaped, acute pointed, an inch or so long, and about half as wide, often also narrowed at base, margins with sharp teeth; these leaves are set close together and nearly down on the twigs; the pink and white flowers, tiny, pitcher-form, in dense, short, axillary, and terminal racemoid clusters—they are nearly or often quite hid, and pending beneath the sheltering wing-like arrangement of the leaves, or only coyly peeping out here and there, to blush in the genial sunbeams; whenever it is found flourishing along shady or half-shady borders of creeks, its overspanning branches arching above the steep banks, in strictly two-rowed foliage, horizontally arranged in due order along each side of the fan-sprayed twigs, as it were, in the act of soaring, this never fails to attract our attention and win our admiration at all seasons of the year. And yet still more is this joyous impress of heart enhanced by the very pretty early spring blooms that modestly gem these graceful boughs. The fruit is black and varnished, edible, but the best quality are more pulpy, and these are usually covered over with a dense blue bloom; the varnished variety are apt to have a tougher skin and drier berry, and are therefore less delicious. It is, indeed, very doubtful if we have any Huckleberries equal in quality with some Eastern Blueberries. Authors speak of the fruit as "insipid," perhaps because they have only eaten it on the cold, damp coast; ten to twenty miles inland, or anywhere along the vanishing fog line, the fruit is much better.

THE RED HIGH HUCKLEBERRY (*V. parvifolium*) is also much sweeter inland than if growing in too dense shades; these leaves are oval, oblong, obtuse at both ends, not crowded; stems angular, foliage in Autumn apt to become bright red. There is a white fruited variety, but the common typical color is coral red. This makes a delicious and brilliant jelly.

THE LOW RED HUCKLEBERRY (*V. myrtillus*), is another smooth, sharply angular, densely cluster-branched, about two feet high, leaves more crowded, ovate acute, entire, or scarcely ever an obscure tooth. Fruit, large, red, and sweet. The flowers of these are small from axils or scale-like leaflets, and recurved on the stems.

THE FAR WESTERN HUCKLEBERRY (*V. occidentale*).—This is seldom seen over two feet high, and for the most, is only a very low shrub, measured by inches; smooth stem; leaves thin, light gray-green on both sides, the form varying from oval to oblong, spatuloid, obtuse, or acutish, rather obscurely so, etc., being one half to three fourths of an inch long, about one third as wide; flowers mostly single, oblong egg-form, the mouth, like the calyx or cup, four-toothed; berry small, blue with bloom, sweetish. This lowly bush, often unnoticed in Spring and Summer by the transient visitor in search of sights and mountain marvels, nestles among the rocks, in steps and damp patches of the steep gorge, here and there; also bordering shallow margins of lakes, stretching far up the entrance, or down their outlets; or, we behold them marshaled in extended marshes, where they accompany sphagnus mosses and such like vegetation as clothes the pseudo lake in its transitional state to the mountain meadow. Unobtrusive hitherto, yet when Autumn comes down the alp, it then boldly paints the landscape in gorgeous hues of gold and royal purple, or scarcely less varied the beautiful tints than the great bow that spans the cloud when the sun smiles benignant to the heavens, weeping for joy! The artist, true to nature, is wont to transfer their high coloring to his Autumn canvas, glowing and burning from out the softened haze. Then comes the censorious critic to question his veracity, having been so often appealed to directly, or plied with questions of skeptical import, whether really any such low Autumn-tinted shrubbery existed, and if so, what? It is but due to say this is the principal painter of the dingle-side and mountain meadow margins when Autumn's benediction is on the head of the mountains, and his yellow hair falls softest and haziest among the hills.

California Storax (*Styrax Californica*).—This is an ornamental shrub of five to eight feet, rarely fifteen feet high, and sometimes gregarious, like the Hazel (*Corylus rostrata*), and of similar size and general appearance, only more upright. The leaves are egg-shaped, often broadly so, and rather blunt at both ends, always so at base, but sometimes slightly sharpened at the top, margins entire, and set on short leaf-stems; in Autumn tints of bright yellow it simulates young poplar bushes seen a little way off, but closely inspected one sees more or less of starry, soft wool. The soft, downy, and chastely white flowers are exquisitely charming, like expanding eardrops, usually much larger than those of the snowdrop or Silver-bell Tree (*Halesia*), and of similar form, but few in the clusters; the pretty contrast of the ten large bright orange anthers render them, in a high degree, handsome; thus, as these short racemes hang from the tops of the twigs, another grace is added to beauty. The flowers are succeeded by a single globular seed, like a small nut, nearly half an inch in diameter, set in the thin burr-like calyx. This kind of half-hazel envelope has a close short downy nap or outside coating. When sheltered, the whole shrub itself becomes more graceful, for where it is much exposed it is apt to become rather too rigid. Not the slightest trouble is experienced in domesticating the California Storax, as no ordinary slight neglect or rough treatment seems to do it any harm at all. Does it not appear very strange to say that such an interesting and altogether available shrub, well known for nearly half a century, is not yet introduced; Mr. Ellis, at the State University, alone excepted. This is another native floral companion of the Service tree before noted, yet with a much lighter green, thin, and delicate foliage, more definitely localized flowers, hence the general and striking contrast.

The Lovely Wild Syringas—Mock Orange (*Philadelphus Lewesii*, California variety, and *P. Gordonianus*).—Among the vast concourse of May flowers, the Mock Orange bushes display their large, frank, and chaste bridal blooms loveliest of the lovely. Grandest and fairest of these forms is *P. Gordonianus;* ten to twelve feet, openly spreading, arching, and waving their ample wreaths, fragrant as the happy Isles at respectful distances; but for too great familiarity it hath little odor of affection. Perched high, as we often see it, a crown of glory upon heaven's own sacred earthly altars—isolated rocky heaps—whereon no profane hands of self-derived intelligent work were ever lifted, nor their cold iron withal; surrounded, too, by the neatest native lawn your eye ever beheld. What wonder, then, the lone beholder, coming suddenly out the dark tangled wild-wood, should stand rapt in ecstatic delight, silent and still, breathless, or tacit, ravished by unwonted beauty, soothed by sweet elysian incense; nearer approached, it glows, living and sensitive in the fond and reverent eye of love, ever gentle, tenderly fearful and reluctant lest it mar the tiniest twig, yea, the chaste bloom of thy youth. These shurbs are too nearly one and the same species, "with variations" as the musicians play it. The leaves, like the branches, opposite, egg-form, or only a little elongated, attenuate-pointed, nearly entire or toothed on the margin, two or three inches long, half as wide, and variously nerved. White flowers, from an inch to an inch and a half wide-spread, rather loosely clustered, and more or less leafy at the base. They reflect a warmer and gayer light than the Snowy Medlar (*Amalanchier*), and usually appear a little later on, when lengthening days bring more abiding heat.

THE PURPLE HEATHLING (*Bryanthus Breweri*).—Few mementos from the alpine regions of California can equal the charming flowers of the dwarf evergreen Heathlings of the high Sierras. These tiny erect, hardy shrublets are about a span to a foot or more high; body usually about the size of a quill, branching at or near the base; the upright branches tipt with somewhat long plumey clusters of rose-purple flowers—these terminal racemes two to four inches long, each flower half an inch or more across, wheel or shallow saucer-shaped, rather deeply five-lobed starry margin, filaments, anthers, and long pistils alike purple-dyed, the eye-like center, bright white to yellowish, and most cheery; the gayest of all the heathers; growing chiefly in peaty *debris* or black rich humus of leafy compost, among rocks, or, at least, beside the transient rillets of melting snow-drifts at from seven to ten thousand feet and upwards on the summits of the Sierra Nevada Mountains. The branches very far back are densely clad with linear, obtuse heath-like leaves one half to an inch long; flower stems a little sticky-glandular, and the odor fragrant as the Isles of Ceylon. Truly appreciated mid its spring surroundings, and what can be more soul inspiring in those serene heights where it blooms nearest akin to celestial beauty; the charming law of unity in variety we see everywhere impressed on men and things, and this forever makes the ceaseless music of the spheres above, below, abroad, extending far * * * hence the myriad associations of whose genesis we know very little, yet in returning affection and with retrospective and introspective thought, we both feel and do know, that they are ofttimes so wedded with the order of nature, and ourselves, the better part of it, they will come back hand in hand fit companions of our past, if no others, perchance, of the vast throng who also commune at her altars.

So also is the song of the little White Cap (*Parus montanus*), that seems to say, as it sings, "O-o-o, see-e-e, the pretty, pretty, beau-ty;" the soft andante, and the slightly lingering stress on the second note, to the attentive listener, is soothing in the extreme; then the ecstatic distinctness, or precise dwelling emphasis on the final note, is of that peculiar sweetness of affection, as if the dear one had a very delicious sugar-plum under its tongue. Early thus do these woodlands resound, and the alpine shrubs respond, every ear is fresh, every song new, therefore is repetition now no longer monotony, but the ever-charming voice of love.

BRIDAL BOWER BUSH. (*Carpenteria Californica.*)

"Is she a nightingale that will not be nested,
'Till the April woodland has built her bridal bower?"
—*Meredith.*

A new and beautiful native evergreen shrub allied to the Mock Orange; foliage narrower, thicker texture, like some forms of willows, but much more densely set; or speaking more specifically still, the leaves are lance-formed, rather thickish or leathery, entire, and the margins slightly revoluted, whitish underneath like the olive; opposite leaf-stems slightly coherent and sheathing the twigs, usually two to three inches long, barely half an inch or so wide. The flowers pure white, fragrant, two to two and a half inches in expansion; tiny bracteolate leaves, ovate, sharp, not "subulate," only quarter of an inch below the flower, central flower stem none. The flowers arranged in flattened irregularly distributed masses successively blooming.

The flowering season is about the middle of May, continuing with a succession of blooms for a much longer period than their only Summer-green relatives. A charming hardy shrub six to fifteen feet high, heartily commended for purposes of rural adornment.

TINY SIERRA HEATHER (*Bryanthus empetriformis*).—This is also another elegant little Wintergreen Heather, still smaller and more branched than the Breweri, being barely a span or so high, tipt with a cluster of rosy-tinted somewhat tubular flowers, pitcher-like, pursed at the mouth, as in the manzanita, arbutus, and huckleberry-bells, and these flowers elevated on naked, or only gland-studded thready-stems, modestly drooping above the erect densely plumy heath-like foliage, emeralding the branches far adown below. A choice ornament for the alpine garden, beautifully adorning inter-rocky spaces of the Sierras at about eight thousand feet altitude here, but further north, coming down quite near to the coast level.

CALIFORNIA SWEET SHRUB (*Calycanthus occidentalis*).—This is an upright shrub, four to twelve feet high, brownish below, pale cherry red above; leaves large, or about five to six inches long and two wide, oblong lance-shaped and sharply pointed, often rounded or slightly heart-form at base, margin entire, rough, lightish green alike above and below, on very short leaf stalks; blooms from April to November; ripens its fruit well; flowers purplish, the numerous thick, fleshy, strap-like petals or flower leaves an inch or more long; a soft bloomy hue heightens the delicacy of the surface. This rather madder-brown hue often becomes tawny or a little bleached at the tips; the odor a very delicate fruity fragrance. These successive flowers are at length followed by an oblong thimble or beer-glass-shaped seed vessel, rough scarred and veined on the outside, smooth and satiny within, and at maturity, unlike the Eastern Atlantic, open at the top. These little erect cups, mounted on stems a few inches long, contain numerous loose and rattling raisin-seed-like bodies. These tiny fig-formed seeds, one fourth of an inch long or more, have a most elegant silky-velvety coating, as if finely bedewed. This very companionable shrub is usually found herding together, by multiplying from creeping roots. They delight in sweet well percolated declivities of rich and often rocky margins of gulches, or lesser ravines, on short primeval rivulets of hills, or, for the most part, contiguous to living springs. Valued for rural culture.

GOLDEN VENEGASIA (*Venegasia carpesioides*).—A stout, very verdant perennial or half-herbaceous bushy shrub, very showy indeed, with abundant golden, or rather brilliant lemon-yellow flowers, blooming nearly all the year round, very bright and cheerful; their gayety in the half-gloomy cañon is rendered still more brilliant against their own dark green leafy background; three to six feet high, much branched, and spreading into a rather symmetrical clump; allied to the chrysanthemums or Christmas daisies. They adorn the distance, but are scarcely at all suited to the bouquet. Its natural habitat also is suggestive, for it flourishes the very finest display in sombre glens and half-shady woods, or perched on the brink of gloomy cañons, or on the sides of the precipice, where the sun rarely shines; here it lightens up the lone surroundings with a radiant glow of glory wonderfully enchanting. For similar purposes it is well worthy the attention of florists.

THE QUEENLY CASSIOPE HEATHLING (*Cassiope Mertensiana.*)—This tiny, delicate, moss-like winter-green shrublet, of a few inches only, with scale-like leaves overlapping in four rows and so altogether on the square, and the flowers pure white, of broadly open bell form, four or five lip lobes, only lightly scolloped, and sufficiently outturned for character—save the pretty pouting—more modestly nodding than even the fair-famed violet, on slender thread-like flower stems, the prettiest, broadest, and relatively largest flowered of our loftiest highland heathers—size of large peas. This is by far the most modest, neatest little belle that ever bloomed; more divinely chaste than classic goddess ever dreamed, the very perfection of all the tiny floral beauties that ever blossomed outside Eden; to other eyes, as to our own, the highest conceivable type of artistic taste, nay, angelic, yet supreme in simplicity, and such of its kind as no natural human eye ever saw its eke. And why should it not be so? Preëminently placed on the most high mounts, serenely above all else, at twelve thousand feet or more aloof from the sensual depths of those dark seas below; and now, as then, and forevermore, commemorative of the chaste wife and all pure virgin souls, ever serenest in pensive beauty, most elevated in purest purpose, meekly enthroned the fairest symbolic queen of all the virtues, emblems of exalted honor, types of the purity of truth, born of the highest mountains, cherished in realms of purest ethers, garlands of the prettiest alpine gardens; naught of earth can awake such pure delight as the fairy Queenly Cassiope Heathling of the snowy Sierras of California.

In all our walks with orderly nature, even in the presence of the conspicuous and more obtrusive beauties that gleam and glow far and near, lofty or lowly, the charm is always heightened by the humble that fill up the measure of natural delight, each playing its own harmonious part well in the grand orchestra that swells sublimely heavenward in the lofty notes of the great *Sequoian Cedar* and their alpine congeners, or more tacitly thrills magnetically along the lesser hills of our humanity adown the fruitful vales to the utmost extremes that make glad the very last and least fibre of earthly existence. These reactive types of objective nature everywhere, higher and highest things of life, are the natural parables of Him who never yet spake to man without a parable.

California Rose Bay (*Rhododendron Californicum*).—Of all the handsomest, most showy, arborescent shrubs that adorn the wild woods of coasts, mountain forests, or the habitations of men with blooms of superior splendor, magnificently mantled in evergreen foliage of great elegance and dignity, few, perhaps none, excel the Rhododendrons. Notwithstanding ours is a noble species, from eight to twenty five feet, or even more, one fourth to a foot in diameter, we believe it has not been introduced hitherto to any extent. Very few of the larger size have altogether escaped periodical fires, are too often well nigh in ruins, bearing broad and lengthened charred records of past peril adown one side, and so were rejected by Mr. William Clarke in aid of the California centennial contribution. It is worthy of passing remark that this species often grows on high coast ridges, and on the borders and bluffs of cañons or precipitous gorges, where only red or yellow loam abounds *without a vestige of peat*, showing that atmospheric humidity, or moisture, to some extent, from precipitating fogs on the half-shady coast, or shady banks of mountain streams, among oaks, firs, and the like, fully suffice for its prosperous growth. However, here the largest specimens flourish in soils of rich local alluvion, mixed with recent leaf and other debris, answering to peat, associated with enormous briar stems, ten to fifteen feet high, two to four inches in diameter, stout enough for one to climb—we allude to the splendid Red-flowered Salmon Berry (*Rubus spectabalis*). The flowers appear from June to August, in large, terminal clusters, condensed racemoid-umbels; color, a delicate rose or pink, broadly bell-shaped; border, five parted, and lobes wavy-margined; throat, brown-spotted above, but none on the two lower-lip lobes; ten unequal stamens included, etc.; leaves large, about six inches long by two wide, elliptical lance-like, base usually slightly wedge-form, on short leaf stems; texture thick and leathery, shagreen-roughened and softly lustrous green above, beneath whitish and very finely net-veined, etc. Among the Rose Bays we find a white-flowered variety, equally evergreen, and in essential particulars agreeing with the type. Extends from California through Oregon to the British Possessions. Deserving cultivation abroad, for there seems little hope at home.

Western Azalea, or the Great Pacific Honeysuckle (*R.* [*Azalea*] *occidentale*).—A large summer-green shrub, ranging from three to twenty feet high, and several inches through, say two to four inches in diameter; grayish flaky bark in age, usually smooth; leaves slightly spatula-form or somewhat wedge-base, sometimes lanced, always tender, very soft hairy, especially on the margin and beneath, becoming rather shiny-varnished above; the flowers appear long after the leaves, those of the coast nearly clear white, or only with a softened broad band of delicately shaded buff-tinge on the upper lip or inside; this bright, chaste, and cheerful white is greatly heightened by the light-green background that brings out in radiant relief the copious masses of flowers. As mementos they cannot be well preserved, on account of their viscid-glandular quality sticking them into such confused heaps in the book. As found on the mountains, or along mountain streams of the interior of the State, or farther south, they are often tinged with rose or purple, rarely yellowish; the whiter forms of the coast north are by far the most impressive beauties known of all the Azalea section. We have seen a brilliant scarlet form (*R. Azalea calendulacea*) in Alabama, more gay but inferior in queenly grandeur. Associated with these Woodland and Swamp Honeysuckles, the sweet seraphic reëchoing numbers of the warbling wood robin, hermit thrush or mavis (*Turdus musicus*) of the East, still roll on in ever reminiscent harmony with the passing years, so the Honeysuckle here, associated with its own little song thrush (*Turdus Pallasi, var. nanus*), both these odors and those notes, though fainter and feebler, again awake to living reality past affections for the fragrant woods—albeit as celestial echoes from off that other Pacific shore—for nature hath also her sweeter subdued songs for the musive soul; her wind-spirits that sooth with softer wings, or murmuring low, whisper and sigh for serener realms afar.

The lasting and delightful fragrance of these boughs hung among clothes no moth ever invades, and the plague is staid.

FRINGE FLOWERED ASH.

(*Fraxinus dipetala.*)

"Through whose broken roof the sky looks in."—*Longfellow.*

Although the common Oregon Ash has a mellow green, loosely expansive leaf, and open general airy shade, apparently flowerless, so inconspicuous are they, yet the white Fringe Flowering Ash of California has a much lighter colored and smaller leafleted plumy spray, more impassive foliage, and an altogether more open and airy top, through which the cheerful sunbeams play upon the lawn in flickered light—the shadow of a shade. When in blossom, the leaves are more mobile, and the twigs graced with a wonderful wealth of white line-like petals pending in effusive pannicles of fringe, which renders it most strikingly beautiful. The tree is much smaller, say twenty to thirty feet high, eight to ten inches in diameter. Smooth in leaf and twig, the feathered leaf of two to four pairs and an odd one, or five to nine leaflets, rarely three, and these an inch or two long, oval or slightly oblong, margins saw-toothed, at length leathery; on very short leaf-stemlets, panicles of white flowers, as it were, poured out, and in pretty profusion cascading the twigs with their tidy, graceful falling fringes everywhere adorning her mantle. Separately considered, each flower consists of two petals, one quarter to one half an inch long, on short claws from a minute cup, scarcely visibly four-toothed; the short stamen threads and anthers, two to four, about equal in length. Fruit, narrowly spatulate, oblong, one inch or so, mostly slightly notched at the end; base, sharp-edged, and in one form wing-margined to the base, with broader obegg-form ash-key; found further south, this has but three leaflets, quite exceptional to the common California type.

This pinnate or feather-like foliage, unlike other kinds of Ash, takes on autumnal tints of prevailing yellow, as the wild woodlands are wont, in the beautiful sylvan sunset, when their day draweth nigh unto its close. Then the little leaflets oft fall away from the main mother stalk, parting at the joints; they seem, however, less unanimous in their final adieu.

The Fringe Flowering Ash, as we have seen, is of such small size and great beauty, light but ample foliage, and delicate shade, rounded top, sightly body, cheerful bark, dry upland and hill habit, inland and occupant of hotter vales, and every way so well suited to adorn rural walks, and outside landscape; it would really seem that the neglect to cultivate it, hitherto, is more due to want of requisite knowledge than to proper appreciation.

We have not dwelt upon the value of the timber specifically, for too little that is reliable has come to our knowledge.

OREGON ASH.

(*Fraxinus Oregana.*)

"Welcome, ye shades of Ashes wild; along the dale,
With woods o'er hung— * * *
Whence on each hand the gushing waters play."—*Thompson.*

The principal Pacific Ash of California and Oregon is not in general quite so large as the Eastern White Ash (*F. acuminata*) of the upper Mississippi Valley, but relative to diameter is taller and more elm-like in elegance; the branches here are seldom huge in the oaken or Eastern ashen sense, but the divisions above are upright or erect-spreading aloft, into easy-sweeping, plumy-curved branches, a few of the lower only reaching moderately towards the horizon, with spray but slightly pending. A tree seldom over eighty to one hundred feet high, two to three feet in diameter; foliage, though large, flexile, loose, light, and soft; as suggested, the top rounded with shorter, lower branches; the fruit greatly resembles the Eastern White Ash; bark not so white, but clayey-gray, rough, and the water-lines elliptically spread or superficially gaping; large branches much smoother, lesser branches and twigs smoothish, save the sparse scabrosities, white dotted. The pseudo-compound oddly pinnate leaf of five to seven leaflets, at length from soft hairy, they become more or less rough (*scabrulose*) throughout; opposite, the leafleted divisions almost stemless, except the terminal odd one, set on a winged leaf-stem about one half an inch long, broad pear-form or obegg-form, obtuse, or often abruptly a little sharpish, the base broadly wedge-shape, margin entire, or with rarely a few scolloped shallow teeth, nearly smooth above, and finally scratchy-rough, especially on the margin, and beneath, as well as sparsely along the common leaf-stalk. The leaf usually consists of two pairs of leaflets, and an odd one, leaflets jointed at their union with the common long foot-stalk, the buds rounded; flowers in opposite fascicles near the ends of twigs from axils of last year's growth. The fruit cylindroid, like a grain of rye, from a minute four-toothed calyx (cup), marginless at base, but gradually margined upwards into a spatulate flattened wing or key, often slightly notched at the end; whole length one to one and a half inches long, less than one fourth broad, rarely three-winged.

The foliage is among the last to appear late in the Spring, when the Signal Ash becomes the advance guard and guide to the florist, that he may now trust his tender plants abroad in the open air, for Jack Frost's Spring departure is thereby announced. He is also first to ground his Autumn uniform, to warn him to return them to their Fall and Winter shelter, for Jack's sinister approach is again suddenly sensed on some balmy Autumn day, when floods of yellow light pour their ripening rays over his worn mantle; "presto, change!" and instantly, all brown and sere, as it were, scorched in the battle fires, they fall away. Thus the "Martial Ash" promptly responds to the great roll-call, and retires from active duty for a season on his parol of honor. That much of this harmony and concord everywhere abound in spirit and nature's laws all mankind are prepared to expect and to heed. The leaf of the oak, when of the size of squirrel's ears, is the Indian's calendar for the best corn-planting time, budding of birch for barley, far north, etc., each relative to their own clime; birds of passage have their calendar of exit and return; insects theirs, as the food of plants and flowers come and go; the fish of streams, lakes, and the great and wide sea, and whatsoever passes through the paths of the deep, have their favorite haunts and holidays; wild beasts of the lonely forest desert their accustomed ranges, when no coveted mast is on the trees, long ere the usual harvest arrives; the sun, moon, and stars, and all the hosts of heaven, have their times and seasons; indeed, all nature, from Alpha to Omega, from which laws the wise will ere long listen and learn. The great dial plates of the heavens and the earth, both point and signify, calling and echoing each unto the other—celestial and ethereal, air, earth, and ocean—the sweet music of the spheres. Thrice blessed the hearts that feel, eyes that see, ears that hear, and they who understand.

The Oregon Ash, noted for nothing ill, time would fail to detail all the good uses in its way in the world. The wood is white, easily worked when green, tough, light, very elastic, strong, lasting, famous fuel, excellent ashes, best smoke for hams and herrings; serves the armorer, soldier, and archer, coach and carriage-maker, cooper and cabinet-maker, ship and wheelwright, machinist and farmer, and if there be any other use indicated in the arts, trades, and manufactures, we ask their pardon for the omission, for this species equals nearly all human emergencies. Have known its use for rheumatic and other pains—leaves rubbed on swellings caused by bites of mosquitoes, serpents, and stings of bees; to remove pains, itching soreness, etc., affords instant relief; antidote to the Lamb-kill (*Kalmia augustifolia*). Why the English and foreigners should prefer it for tanning, in certain cases, we do not know, but presume there is some good reason.

Found in rich moist bottom lands, along stream banks and marsh borders, from Fresno (Ash) County, along Coast Range north throughout Oregon, and to a great degree, California.

NUTTALL'S PACIFIC BOX—THE GREAT FLOWERING CORNEL.

(*Cornus Nuttallii.*)

"The glory of Lebanon shall come unto thee,
The fir tree, the pine, and the box tree together,
To adorn my sanctuary—
And I will make the place of my feet glorious!"
—*From the sublime poem of Isaiah the Prophet*—Sec. lx, 13

"Ye nymphs of Solymy, begin the song—
To Him sublimer strains belong;
O Thou my soul inspire
Who touched Isaiah's lips with hallowed fire!"—*Milton.*

With the great serene redwood-cypress, or colossal cedars of the coast, as they may well be called, grand and ever-vernal fir trees, yews, spruces, pines, oaks, and others together, beneath and among them all by far the most magnificent sylvan bouquet of California or Oregon is the great Box Tree of the Pacific. No floral denizen of the forest strikes the stranger as so impressively bold, grand, and gay as those chaste white blossoms, one fourth to nearly half a foot across, well distributed over a tree twenty-five to seventy-five feet high—nay, eighty to one hundred in some rare instances.* Body of relatively small diameter, ranging from ten inches to two feet; bark dark red, verging to black, very finely and evenly cuboid-checked. The surprise when suddenly confronted by this bright sylvan bouquet is even startling, save to one long familiarized to charming native forest scenery; and few, if any, of these can be found so indifferent to a proper sense of the beautiful as not to, ever and anon, reawaken, renew, and full oft increase their admiration at each recurring Spring. Like the bright shining after May showers, so also is our own delightful experience and observation of the effect of this choice tree amid the wild woodlands. In general outline it is oblong-conic, and, as usual, in age of more roundish top; the relatively naked spreading branches with somewhat open, upturned, purplish-green, rather stout twigs; they have the opposite foliage, chiefly condensed, and rosulately radiating their tip ends; these large—four to six or more inches long, and three and a half to four wide—broadly elliptical leaves are feather-veined or nerve-like, sunken above and prominent beneath, the texture of the blade thin and tough, somewhat abruptly sharp-pointed, often broadly wedge-form towards the short leaf-stem, the brief scattered hairs turn back, and are more or less close-pressed above, rather more confusedly half-woolly beneath, and the hue lighter grayish-green, "gloaming the twilight grove," changing again in mellow Autumn sunlight to gold and royal purple. From the end of these final branches, supported by a stout foot-stalk, one to two inches long, are set the large white involucral flower-leaves, four to six in number, two to three inches long, and half as wide, nearly like the proper green leaves. but often notched at the end; these are what appear like great petals, and go to make up that grand floral display we behold, but the true florets are at the eye-like center, being too small for casual observation. Here also at length appear the spherical heads or bunches of bright scarlet berries, one

* Sect. 4 CK. Mendocino County, J. Clarke.

hundred and forty to one hundred and fifty, of which, fifteen to thirty mature, or say, usually about twenty-five, here they crowd and nestle, emblazoning with livelier cheer the somber Autumn shades; separately they are tiny, say half an inch long and about half as wide, oblong-egg like, abruptly black tipt, commonly so compactly crowded together as to become quite angular; these very ornamental clusters are even largest and brightest red in the dense secluded woods, and there only rivaled by the brighter scarlet and purple foliage shading to iris yellow; forests by no means solitary nor deserted, but only quiet, as it were, far from the common walks of men; here we may read undisturbed, if wont to peruse any page of the great book open before us, perchance know, here and there a few floral, sylvan, or other famed characters of her living alphabet, if not technically, yet to all intents and purposes, truly, so as to begin to combine them in the order of her harmony, or at least to appreciate them when so combined; then, what if these trees climb some tall, steep glen side, bow low and lean off the precipice, becoming picturesque, quite athwart the narrow defile, or spanning the mirrored brook, arching up over, shooting high the tented top that beautifully embowers the pools below. Here the frisky gray squirrel, pigeon, jay, and other wild game are wont to seek them out for food, and later on, they glow upon the ground, and gleam or glimmer in the beds of creeks, from beneath the cool waters, where the speckled trout sports, and the playful 'coon roves at large up and down the deep retired ravine; along these banks and bars the watchful wildcat, couchant, springs upon the great salmon trout left by receding floods; there are the pretty martin or mountain cat, mink, and the fisher, there also roam the bear and the lion seeking their prey, and here the sly fox and prowling wolf find their favorite haunts, and the nimble little lank redwood deer oft returns to slake his thirst, besides unnumbered beasts and birds that retire to these romantic shelters for refreshment, and for rest. Thus doth natural scenery with its ever varying associations "unadorned" by profane human hands, leave freest play to refined edenic pleasures, "where no vile surfeit reigns," and no weariness of wealthy display obtrudes, where the ostensible and artificial humbly acknowledge their peerless real. But would any one, in this conceited age, have the audacity to imagine a real philosopher (truly loving wisdom, rather) soliloquizing, "This natural object, and that, or those scenes combined, impress all variously, and forever will, as now, along the rolling ages, effigies of the Infinite; hence, indefinite, a very small part of His works, the views of passing human ephemera, the least of all His wonders." But soon the balmy days supervene, silently signaled on forest foliage, as stars of honor on the breast of worthy merit, when the year, and all his types draw nigh unto their quiet close; then a saddening retrospective repose comes down in floods of yellow light embosoming wild and lonely wood, languid fields of harvested plenty, serener mountain tops, more tranquil vales of fragrance, softer winds fan our cheeks, and expiring zephyrs sigh faintly æolian songs, echoing the firmament of the pine and the fir from on high, with the "still small voice of silence," wherein celestials whisper unto the soul, saying to the all-attentive ear, "Yonder is a brighter harvest in the skies;" earthly flowers may fade away, gay leaves fall lightly down, or as bright banners of a vanquished host, lie scattered and prone along all paths of hasty flight. But already the buds of promise appear beside the fruited fork, between the final two parting twigs of the Great Flowering Cornel—another life begun, for death is but the beneficent beginning of a new resurrection.

"Life is real! Life is earnest!
And the grave is not its goal;
Dust thou art, to dust returneth,
Was not spoken of the soul."

THE GREAT FLOWERING DOGWOOD of the Pacific, like its kindred of the Atlantic, is also of slow growth; wood hard and heavy, texture close and color dark, takes a fine polish, called native Boxtree, the timber being often substituted for boxwood for joiners' tools, handles, and turnery generally; makes elegant mauls and mallets, is beautifully ornamental when well selected, best near the base, and with instep-root furnishes good knees, similar to cedar, pine, oak, and yew, good boxes for gudgeons, and cogs for wheels; young, straight stems, hoops, etc.; and in the "good old primitive times," long gone by, when female, from queen to peasant, and the "old folks at home" were wont to put forth the hand unto the distaff, the orderly disposed branches whirling the slender stems furnished that implement for the spinsters. The very bitter aromatic bark affords an excellent tonic, astringent, antiseptic, and febrifuge, and like peruvian bark, is of like efficacy, yields cornine as that does quinine, salts of similar medicinal value; smaller branches for stick brushes are used to render the teeth extremely white; the smaller roots yield a scarlet dye, and the bark has been used for tanning. Found along the whole coast range north to Puget Sound, in Oregon and Washington Territory east into the Cascade Mountains.

WESTERN LARCH.

(*Larix occidentalis.*)

* * * "trees in tears of amber run,
Which harden into value by the sun."—*Ovid.*

Ovid also describes the sisters of Phaeton as having been turned into Larches. But by modern magic processes the custom is now reversed, and Larches are turned in phaetons for the sisters of our day; a decidedly delightful improvement on the old plan.

The Western Larch is an open, spiry, star-spangled, deciduous conifer, with short and slender depending branches, with no proper boughs nor sprays; therefore, most of all trees, naked, bare, and dead-like in Winter; but if space and air be allowed to encourage and maintain lower branches, they will live as long as the tree survives, to add beauty to the base and more general comeliness throughout; there needs also sufficient shelter to produce the requisite height. Thus, with branches nearly or quite sweeping the ground, thickly set and successively lessening aloft into elongated conic symmetry, the tree is then not utterly spiritless even during the Winter months, as all deciduous trees and shrubs must needs be, more or less. And as all art, especially in architecture and in nature in the landscape, has respect to humanity, at least in some points of view, could the ideal expression be considered complete without these various types of repose and rest—sleep; nay, the lowest reactive symbol of apparent death itself; even bordering upon the dark confines of the real before it burst into renewed life with all its charming and ever changing surprises.

The Western Larch of the coast of Oregon and northern California, where it grows scatteringly along the banks of streams; is one hundred and twenty to two hundred and fifty feet high; two to three feet, rarely five, in diameter. In the larger specimens the rather insignificant branches give it an air of devotion to body-timber, like the colossal Redwood (*Sequoia sempervirens*); but this is, to a great extent, characteristic of nearly all the forest trees of North America; only with the Larch and a few other intrinsically tower-trees, perhaps a little more so.

The trunk is strictly straight; in deep gorges, the clean and handsome lower shaft is fifty to one hundred, or in rare instances even two hundred feet, true as a plumb line; consequently straight-grained, and, in respect to this tree, free-splitting. Larch literature is very voluminous, and the uses so manifold, universal, and super-eminent that time would fail to even touch the varied topics. Suffice to say the timber is exceedingly tough, light, and elastic; in river, ocean, harbor, earth, and air structures of the severest trials, far excels the staple timbers of the world, such as oaks, pines, etc. Unfortunately this species is never massed in forests, nor thronged in swamps, like the Eastern Tamarack (*L. Americana*). But our Larch loves a due degree of sun light, pure refreshing air, sweet percolating soil; dry above, so that no night evaporation ever suddenly chills, and where the genial currents of air are swelled and lifted up at night from free, broad, and contiguous vales that share their bounty with the little valleys between, neither arid nor foggy, abounding with moisture beneath, fed by living fountains, or established beside rapid rivulets that keep moisture continually in motion, ever laving lower rootlets, but never drowned beneath floods of wintery rains, nor parched by droughts of burning Summers. But let us return and review her specific characteristics a little more in detail. Little needle-like leaves, long, relative to other species, and very slender, even delicate, radiating in spangles fasciculoid from bud-like rudiments of twigs; potentially designed as such, but apparently falling short in the realization. Thus we see these very narrowly life-like leaves weak and softly starry, light and airy, as it were, verging well nigh upon the unsubstantial, pale bluish-green (closely inspected, slightly keeled above and below); thickened and massed, as they sometimes are, near the middle of the tree, the softened effect is like that of the Great Swamp Cypress (*Cypressus disticha*). Seen in Spring, decked in pink tassels, like ripe strawberries thrown over the lofty pea-green cone of delicate foliage—if anything so gauzy or gossamery is entitled to the dignified appellation of foliage, in any ordinary sense of the word; but there she stands before you in singular beauty, the veiled Venus of the grove, basking in early Spring and Summer, loveliest of the lawn. Albeit, later on, as the season advances towards Autumn, the foliage becomes more dingy yellowish green, and at length yellow, when the year garners her gold with the joy of harvest.

The cones are of the size and shape of a pigeon's egg, or about one and a fourth inches long, and about one inch broad, bent back on their short stems; scales of the cones membranous, short, rather broad, egg-form, obtuse, often a little scallop-notched on their edges; bract leaves, imperfectly elliptical, with fringed ends, the long awn or mid-ribs protruding beyond. (See our sketch of it in the VI Vol. P. R. R. R., page 59.)

PACIFIC PLANE OR SYCAMORE TREE.

(*Platanus racemosa.*)

> "The heavy-headed Plane Tree, by whose shade
> The grape grows thickest, men are fresher made."—*B.*

> —"Broad-leaved Plane Trees, * * *
> Where, round their trunks the thousand-tendril'd vine
> Wound up, and hung the boughs with greener wreaths,
> And clusters not their own."—*Southey.*

The Plane Tree of the Pacific is a summer-green inhabitant of valleys, where the roots reach water, and the soil, free from stagnant moisture, is never dry; with some shelter, access to sun, equable and genial moist air, it is a tree of great magnitude and wonderful majesty; the huge branches spread greatly, and the twigs are divergent and distant from one another, according to the size of the leaves; hence, in Winter it is more open than most other trees to the sun's rays. Pliny says: "There is no tree whatsoever that defends us so well from the heat of the sun in Summer, or that admits it more kindly in Winter." Few trees are so favorably formed and foliaged for ventilation; it is, therefore, no wonder in the Orient they believe, as stated by Evelyn, that, "after a raging pestilent in Ispahan, since they planted a great number of these noble trees about it, the plague has not come nigh their dwellings." Like similar trees of large foliage, they often seem too naked, but how else could they hang out free the pretty tassel-threads strung with long, graceful, and beautiful catkined balls, that dance so merrily all the live-long year, chiefly cheering the winter months? In early Spring the great magnanimous and tropical leaves appear; these palm-like leaves are more deeply lobed than the Eastern Atlantic Plane (*P. occidentalis*), being half to a foot and a half across; but they find room enough to expand, and a free Summer-field to flash their bright, cheerful, and flickering faces along river banks, in fruitful vales, and at the gates of wilder glens; although so open and airy, as observed, the shade is, nevertheless, cool and complete; the milk-white bark so scales off perpendicularly as to become the purest, neatest, and most gladdening tree of all the groves—a cool, snowy, sylvan alp in the midst of the vales! It is, however, only here and there one, or few, among a host of darker trees of the forest, at our northern coast limits, where the contrast makes it the most striking object of the landscape—a perfect marvel of beauty set in such sombre wintry scenery, like a bright angelic visitant, cheering the wilderness and the solitary places; recalling scenes of early days, when the delicious and musky fragrance of the Wild Isabella or Fox Grape (*V. Labrusca*) swayed its long vines pending the lofty boughs, free in mid air, fifty to one hundred feet or more, like the great ropes from the masthead of a "Man of War."

How it ever got there, was the juvenile mystery of those days, when transient thought was lightly turned on the how, the why, and the wherefore, this, or that, was there, for "happily unconcerned, in the enjoyment of the present, and of the daily bread; or later on, beneath these academic shades reposing, with sundry favorite poets in converse the while, all the live long Summer nooning gloaming, between refreshing lunch and labor, we passed the usual day's duty;" thus are these Plane trees associated in our memories with ten thousand charms; perhaps, to some, 'twere wiser unnumbered (?); indeed, we seldom dare touch, or but faintly and feebly, the harp-strings of the heart *con amore*, save to the innocent and unperverted ear of childhood. But could the Plane trees tell their own tale, ancient or modern, what poems, what songs, and what profound philosophies would we not have? Planted, as it was, along all avenues, beside all walks on orient or classic ground, near their gymnasia—all public schools in Athens—constituting the honored groves of Epicurus, where Aristotle taught his peripatetic disciples, shady walks of all public buildings, the groves of Academus, in which the vast sense of Plato echoed from the great empyrean of his intellect as he delivered those celebrated discourses. Here, too, the sacred Homer, outcast and wanderer, sang as no other poet ever sung. The enchanted but vain Xerxes must needs tarry beneath the fascinating shades of the sycamore of Lycia, belt it with a ring of gold, adorn it with jewels, impress it upon medals, and leave it in charge of one of the choice ten thousand. Time would fail to recount a tithe of its lore, even by name, for it has been greatly celebrated from the earliest records of Grecian history, and long prior, in the Orient, whence, not only much literature, but the tree itself, has been imported—nor do any of them yet known equal our own.

One of our charter members of the California Academy of Sciences, the late Col. L. Ransom, used to relate his own observations while surveying the lands of Ohio, bordering the Muskingum. His party taking shelter from a storm in the hollow of one of those eastern Sycamores—found he could twirl his twelve foot measuring-pole horizontally over their heads; into another fallen tree a cow had entered and housed,forty to fifty feet or more towards the light of a large knot hole, was too stupid to back out, and the hole was enlarged for her exit. Michaux, measured some of these enormous trees, and found them thirty-six to forty-seven feet in circumference.

The Pacific Racemose Sycamore has an altitude of eighty to one hundred feet or more, rarely over six to eight feet in diameter, the spread often equals, if it does not sometimes surpass, the height; towards the south the foliage is magnificiently tropical, it is however, found to vary greatly in size and wooliness. Perhaps there may prove to be two species: *P. Lindernian and P. Mexicana* come in beyond the southern boundary of the State, and *P. Wrightiana* in Arizona. Although all our forms of *P. Racemosa*, as at present constituted, are loose, the southern one is certainly most open and tends to spread very widely its divided body; this, in the vicinity of San Diego, its extreme limit is often a smaller tree than at Santa Barbara and those approaching central California; and nearly all of them are closely surrounded by multiplied shoots from the common root, origin of the central parent tree; these trees have a rougher dark brown bark below; it is not known whether they are of equal age, notwithstanding their smaller size. The typical tree when dismantled of those ample palms, and the sparse branches seen so nearly naked, almost bare against the sky, strike one as much more ungainly than oaks in similar condition and even than many other large-leafed trees.

There is here, as elsewhere, often a sudden blackening and withering of the young Spring leaves, as it were, by frost, but young and vigorous trees escape, or at least the central leading top, showing intrinsic and internal vigor, but peripheral weakness of some kind. If not killed outright by this chill (not frost), it is found that season they bear no fruit; this is the mysterious transcontinental "Sycamore blight." The delicate sympathy of the Sycamore for the loss of her sylvan companions is very remarkable; sensitive to sudden shocks, and even slight irregular changes in climatic conditions, especially fitful atmospheric, for it is in a high degree an aerial tree, and requires, as well as helps to maintain, the gentle seasons that tide the rolling year. When these are no longer unified to give a lengthened rest, like a gradual Indian Summer close, into a cool, consistent, well-marked clime, one nurtured on the bosom of balmy breezes, forested and filtered, sheltered and tempered, duly agitated, aerated, and restored, also softened with wonted moisture, in short, vitalized; so conditioned, it goes forth caressing to health, saying, as saith the sacredly classic love-song, "I charge you, O daughters, * * * that ye stir not up my love until he please, * * * until he come up betimes from the wilderness leaning upon her well beloved." Unlike the Alder nymph, that seems more solicitous of the pure element at her feet, whose sudden withdrawal is her immediate death warrant, this Buttonwood tree, on the contrary, being of more general vitality, repines at its aerial loss as well, but may spasmodically struggle on a weakened and precarious existence for many years; the tree, however, is probably constitutionally, or by its own nature, sound enough, but it is man and his wanton ways that are unsound, cutting off the reserve source of humid and aerial supply, the great forest diverticulum, thereby disarranging an orderly equilibrium and although the plane tree is among the first to feel it, yet neither man nor his useful products are altogether exempt from its baleful influence. As neglect of compensating vegetable life would bring disaster and death into that other fluid of the aquarium, so with all things of the fluid air. This, briefly is our *rationale* of the great north continental Sycamore blight—blight in a tree of all others least infested with fungi, insects, or only frequented by *Phlœodes pustulosus*, and a few others of no apparent harm; or finally, if inquiring into causes thus made manifest, can it be that this classic tree, and age alike, are passing through an age of blight, impending death? If so, we will wait yet longer for the coming philosophic poet to write that epitaph.

For a tree of such rapid growth and great size the wood is excellent; commended for lightness, close homogeneous grain, whitish or faint reddish tinge like beech, and fine silver lines of beauty; these very finely glistening medallary rays resemble beech-wood, but take a brighter polish, yet it is quite too soft to be otherwise compared to it. The lumber requires to be very slowly dried in the shade, so as to avoid rapid shrinkage and season-cracks; sawn slanting, the ray-markings are charming, and the curled grain of the great forks still more so. The clear timber generally is used for bedsteads and other furniture; and as the wood works well and easily in all directions, is fine for scroll and cabinet-work, all kinds of turnery, buttons, clothes-pins, rollers, mashers, etc.; the Mexicans make their wooden stirrups almost entirely of it, for it is light and not at all liable to split; however, for some kinds of furniture it is objectionable on account of warping; it also makes excellent fuel when dry, and for this purpose esteemed for its rapid growth.

FREMONT'S CALIFORNIA COTTONWOOD.

(*Populus Fremontii.*)

"Some ply the loom—their busy fingers move
Like poplar leaves, when zephyr fans the grove."—*Pope.*

This large tree abounds from the Sacramento Valley south to San Diego and far towards the Sierras, and is said to extend eastward into contiguous States and Territories. Flourishes in rich light alluvion, proximately bordering river banks, or springy, where at least, their roots reach water; is of very rapid growth, and attains to one hundred and fifty feet in height, four to six feet in diameter; bark of ashy-clay color, and roughened chinky on the main body below, lesser branches and twigs creamy; these outer check-sections are so light as to afford a fair substitute for cork. The branches are much spreading, and the general spray of the tree is open and airy, the large leaves serve to form a dense shade, as usual with poplars, leaf-stems about as long, or longer than the blade and latterly flattened; upland form altogether naked and smooth throughout, and very conspicuously bayed at the base; the bead-like cotton pods are arranged on nodding or erect racemes, like currants, usually three to five inches long near the terminal part of last year's growth; seeds white, capsules three to four valved.

For extended parks, avenues, and roadways, and for suitable localities, or cities, this native poplar is the best available substitute for that balmiest of all balmy trees (*P. balsamifera*), that whilom shed its entrancing sweet ethereal perfume, far and near, over the halcyon days of our early youth. The pretty pink-blossomed male tree, only should be chosen, as the female trees shed their cottony seed so profusely, like a flossy snowfall of down that persistently refuses to let go whatever it touches, until the annoyance, to sensitive natures, is voted a nuisance.

The timber is somewhat less white than the Aspen, and on thoroughly drying loses more than half its weight; makes excellent dry goods, wine, fruit, butter, and salt boxes, peach baskets, etc., and all sorts of white wooden vessels, trays, bowls, certain staves, clothes-pins, spools, and similar turner's ware in general; and is at the East now ground into pulp for paper. Is also dignified to use as ceilings that take paint well, and are seldom or never infested by insects; is in good repute for rafters and sleepers where some spring or elasticity is requisite. Its challenged durability when dry, is commemorated in the old, oft quoted distich of proverbial lore—

"Tho' heart of oak be e'er so stout
Keep me dry and I'll see him out."

And still it holds good. Cattle are fond of the young shoots. Horses are kept in good health by gnawing the logs, and sheep and beaver thrive on the bark; as a special favorite food, mixed with oatmeal, it has been used for human sustenance in times of great scarcity, and for aught any can say, may be again. To the poetic, artistic, and romantic eye, the sunshine ever dances in active glee among the varnished and restless foliage, and some are said to see therein, their fair one—

> "As the green poplar leaves in wanton play,
> Dance for joy, at rosy break of day."

Others, in graver mood, may apostrophize in this wise:

> "Lord! all thy works are lessons—each contains
> Some emblem of man's all-containing soul—

And add—

> * * * "nor let my love
> Among thy boughs disdain to perch and sing."

And—if willing to believe it—a staff, scepter, shepherd's rod, or crook, made of White Poplar in the olden oriental times, denoted the ability or power of good, by suitable natural truths adapted to the state of their flocks, or peoples, to guide them to the good pastures we read of; they also signified and served as supports to their own bodies, hence the universal use by shepherds, judges, kings, priests, prophets, and travelers—as understood in the best emblematic sense—and also in the opposite bad sense, their use by magicians. Rods of the hazel and plane-tree were used in a somewhat lower ideal, or symbolic sense; for all trees, with variety, were emblematic of man's perceptivity, and were so used with due regard to true correspondence, representation, and rightful figures of speech.

This stately poplar is neither so slender, towered, nor so conic-topped as some others, but with rather large irregularly rounded head; the drip and shadow is not injurious to vegetation which thrives well under it. In Autumn the foliage brightens very brilliantly yellow, especially in the higher inter-vales of the Sierras and the more arctic regions.

VINE MAPLE.

(*Acer circinatum.*)

> "The dying charm of Autumn's farewell smile."—*Anon.*

Of all the splendors of forest foliage as seen in the wild woodlands of an American Autumn, no gay and festive leaf can compare with the Vine Maple for brilliancy of coloring or for beauty of form; radiant nerved and glowing as ten thousand little sylvan suns in yellow gold and royal purple, spangling her painted boughs—pretty as an infant's palm—causing the heart affections to leap for joy, as the young roe upon the mountains. Flowers may bloom and fruits blush, brighter berries cluster as rubies and gem the bowers, but these leaves glow and burn brighter still—bright as the rose of Eden on love's own bosom—brilliant as the bow that spans the heavens in the bright shining after May showers.

This large shrub or tree, in California, is seldom or never over twenty or thirty feet high, although said to reach forty in Oregon, and from eight to ten inches in diameter in Mendocino County; bark green when young, whitish in age; it has an arching vine-like habit of, as it were, leaping up and bending down, and wherever the top touches the ground taking root, and so traveling, meanwhile numerous offshoots spring up, interlacing in all directions, forming almost impenetrable thickets or clumps. This natural habit of layering is also often noticed in the Red Swamp or Soft Maple (*Acer rubrum*) and Mountain Maple (*A. spicatum*), and some others, but in none so invariably as this species. Next to the Vine Maple as an Autumnal ornament, is this Red or Crimson-leaf Maple. The common appellation of "vine," is designed to express both the form of the leaf—being vine or grape-like—as well as the vine-like habit of the shrub as to body and branch.

The wood is very hard and close grained—one of the hardest of maples—and takes a fine polish; valuable for minor purposes. The wood is white and exceedingly tough; the young and slender branches make excellent hoops, used by the Indians for their salmon scoop-nets, etc. The leaves are much more heart-shape, sinused, or bayed, than Hooker's plate (Flora and Forestry of North America), and not at all palmed by the united veins or nerves at the inserted point of radiation at the top of the leaf-stalk, and only seven-lobed (rarely rudiments of two more subsidiary lobes at the inner margins of the sinus lobes); the canaliculate slender leaf-stem from one to two inches long, about one fourth to one third less than the roundish blade, in Autumn smooth, with a tiny tuft of hairs at the base or center of radiating nerves, rounded heart-shape, deep and gracefully sweeping but sharply cut sinus, lobes sharply lance-shaped, divided nearly to the middle, margin saw-toothed or sharply doubly so, *i. e.* teeth upon teeth; from five to twenty flowers, in umbels at the end of a slender minutely two-leaved or bracted common flower-stem; the velvety cup purple, sepal divisions longer than the green ash-white petals, stamen threads also velvety hairy at the base; wings of the two seeds spread at right angles, about an inch long. Lest the casual observer be confused, it is remarked that there are really three kinds of flowers: First, *male flowers*, with oval crisped petals and no gland at their base, nor trace of any pistil, but in lieu of it a tiny tuft of white hairs—the stamens inserted upon a large orbicular fleshy cushion or gland. Second, *female flowers*, with two styles to the twin germs, which, with the eight imperfect stamens, are inserted on the receptacle, but having five small fleshy glands, at the base of which the line-like petals are inserted. Third, *flowers* with ovate crisped petals, eight perfect stamens, embryonic pair of seeds and only one central style, all on a large circular fleshy cushion or disk. This species also furnishes a sweet sugary sap.

THE GREAT RED ALDER.

(*Alnus rubra.*)

"She loves the purling streams, and often laves
Beneath the floods, and wantons with the waves."
—*Virgil.*

The common cognomen, Alder, is apt to be associated in our minds with familiar forms on the mountains, or in other lands, and hence signify some sort of bush or large shrub; whereas, this Pacific Red Alder, *rubra* species, is a large and handsome upright tree, forty, eighty, or one hundred feet high, two to four or more feet, rarely six, in diameter; clean shaft, twelve to forty feet and upwards; bark of leaden hue, or lighter whitish and smooth, in extreme age becoming roughly creviced and almost black at the base; the branching portion somewhat elongated-elliptical, or conic in regular outline, except in great age, when it becomes more round-topped; but the usual forms are, in a high degree, symmetrical; they also maintain their broad leaves so perfectly horizontal, and the spreading branches so nearly so, as to afford one among the finest, most open, and airiest of canopies—what was designated of old as the dense "fat shadows," beneath which the green grass and the tender herb continued to flourish. They are, therefore, trees, or large shrubs, with alternate deciduous leaves, at first plaited and folded in short stalked buds, and protected by a single scale; aments on branched stalks, the male in long cylindric tags or catkins pendulous; the female cone-like strobiles, short, ovoid, and erect, becoming at length like redwood; cones egg-like, consisting of wedge-form scales grown together, fleshy and abiding, from green becoming ripe-brown, and after shedding the small, cinnamon-brown parsnip-like seed, becoming black and slightly open, not falling off with the seed altogether.

A few of these riverside trees, for variety, in parks, or portions of avenues suited to their habits, and for fringing meandering streams, are remarkably ornamental, and also very desirable on account of rapid growth, for the vigorous vivid green, and evenly distributed verdure, so pleasing and agreeably tranquillizing when associated, like the willow, with its own proper element, and, we may add, equally appropriate for lawn or meadow.

This large Red Alder, in age, also attains somewhat to the bold, resolute, dignified, and picturesque port of the oak, for which, at some little distance, it is not unfrequently mistaken; a nearer approach, however, reveals a livelier depth of green, general egg-form, and doubly fine-toothed, feather-veined foliage, and a much more airy spray. To our mind, there is always a cheeriness of expression, which it seems never to lose altogether, although this feature is more manifest in its early growth and later prime; in short, the general tone of the foliage is at all times of the free and easy sort, and ever "wavers in the wind," perchance borders close upon the negligent and the careless, more especially so in partially retaining the deciduous leaves so very late in Autumn, or early Winter, when they appear more disheveled, simulating venerable age and its own apparent infirmities, nevertheless well in keeping with surrounding scenery then and there. Alders akin to the birch belong to the few, as we see, who linger long and later by living rills, babbling brooks, or deeper water ways that "go softly;" but at length she modestly retires from manifest view and, deliberately dismantled, rests with the close of the year.

Dwelling only on the banks of living streams; whensoever the Pacific traveler, weary, thirsty, and fainting seeks water, but finds none, deceived by poplars, myrtles, willows, and the like, wont to grow by the brooks, if from afar he beholds this pinnacle of his hopes towering above the long verdant line of various trees that wind along the vale, suddenly he hails his hopeless or hope-deferred companions with the joyous note of triumph, for lo, the truth-telling tree! "That candid and honest old alder there never lies." Yonder green tent is ever pitched above living waters—symbol of sacred truth; nor can any false flattering streams lure her above the pure perennial fountain head, where, like the immortal nine, she may forever bathe in everlasting springs. No, nor does the sacrifice of the tree banish the timber. With the more real Naiads of flesh and blood, in the form of washboard, bowl, or machine, they still play there merrily, "all on a washing day." Like the willows, their multiplied shallow roots preserve margins from the wear and tear of aggressive streams, and during the hotter portions of the year, shelter, cool, and sweeten them, and together with the falling leaves, infuse and tone sluggish and stagnant waters. It is certainly worthy of special note, that like most mineral waters, stock always relish these discolored pools best. The flesh of trout, then and there, acquires an aldery-tinged color and quality. The leaves are of some repute as fodder, the bark for tanning, and with twigs, tags, and young wood, as a tonic, in teas, beers, etc.; for diseases of the skin, as detersive and expectorant, and a gargle in ailments of the throat; for ointments, etc.; colors green, red, brown, yellow, and black, and sundry intermediate tints, according to the treatment.

The light soft velvety wood is at first white; freshly exposed to the air, the sappy chips become red; the timber, permanently of a delicate creamy color; the closely interwoven fibres render the texture homogeneous, and its tenacity prevents splitting, although not of the class of tough timbers, which greatly adapts it to such uses as similar woods are applied, viz, sculpture of wood carvers, machinery turnery, and for furniture and cabinet purposes, etc. The knotty parts and roots furnish choice solid or veneered curled ornamental work; previously immersed in mineral springs, it becomes almost imperishable, or buried in bogs of black peaty muck for a few months, with added lime, in these swamp water pits, and then, when taken out slowly seasoned, smoked, and the furniture well varnished lasts for generations, quite unmolested by insects—when long lain in these peat bogs it becomes black like ebony. In a large way it is highly esteemed as piles for the foundations of bridges, and the like water-structures; kept constantly under water in mines, flumes, pumps, water-logs, fish barrels, boats, and canoes, etc., is exceedingly durable. Finally, among the thousand uses, the long slender fibrous roots, when split, serve for making baskets; but too many good uses have already been noted. Illustrious old Alder! Associated with childhood scenes and charming by-gone memories of the mines, where we sat beneath her shade—yea, slept and dreamed the happy golden dreams that grosser gold can never buy; bless the good tree! though we never rest under her shadow more—yet her soft refreshing voice still vibrates on the heart-strings of that harp of a thousand,

> "Like the whispering breeze,
> That lulls on the leaves and dies among the trees."

THE FAR WESTERN PACIFIC BIRCH.

(*Betula occidentalis.*)

"Rippling through thy branches goes the sunshine,
Among thy leaves that palpitate forever;
* * * Thou art to me like my beloved maiden,
So frankly coy, so full of trembling confidences;
Thy shadow scarce seems shade, thy pattering leaflets
Sprinkle their gathered sunshine o'er my senses
And nature gives me all her Summer confidences.
* * * Thy ripple, like a river,
Flows valleyward, where calmness is, and by it
My heart is floated down into the land of quiet."
—*Lowell.*

The Pacific Birch is a modest unpretentious tree, delicate, light and airy, spiry and sprightly form and aspect, seldom more than fifteen to thirty feet high by five to ten inches in diameter, extending along the eastern slopes of the Sierra Nevada Mountains of California for many hundreds of miles, around north and west to Siskiyou County, and indeed to Washington Territory and Rocky Mountains, and so southwesterly into New Mexico. In our sparsely timbered regions bordering the sandy deserts, as *e. g.* Owen's Valley region, and there it is found higher and highest, chiefly between four thousand and ten thousand feet altitude. Here it is in much request for a greater variety of domestic and rural uses than some other more valuable timber trees of difficult access. To our own standard of observation, its growth and general appearance greatly resembles the Eastern White Birch (*Betula alba var. populifolia*) of old pasture fields, save that the bark at the base often becomes black; is not so purely white above, and the cherry-colored twigs copiously sprinkled with small white resinous warts; slender leaf-stems shorter, hence the tremulous aspen-like motion, though less in degree, is somewhat compensated by a lighter hue beneath; form rather broadly egg-shaped, the fine teeth gland-tipt, etc. Bordering such dry and arid regions, it is not found far away from the banks of mountain streams, but usually follows along their courses valleywards. The timber is tough, and, kept dry, durable—*bezo*, birch, and still it is used for making besoms or spray-brooms for rough sweeping, for crates and wicker-work, hoops like the hazel, good for gunpowder charcoal like alder, and for crayons like the willow. We noticed it used for wagon-tongues or poles, for fencing and fence bars, and for sundry other farm, rural, or domestic purposes.

The Far Western White Birch well represents the Eastern in the close smooth bark, which greatly serves to protect and preserve the wood, and is therefore often left on; this property, common, more or less, to all the birches, is most extraordinarily exemplified in the almost imperishable quality of all the sheety or laminated papery-bark birches exposed as roofs, etc., to sun and rain, or even buried in bogs, when it lasts for many thousands of years; in America, at least, never sufficiently appreciated nor duly utilized. In Russia, and elsewhere to less extent, the crude essential oil combined with empyreums from rude earth pits, in the manner of coal pits, has been long in use for dressing leather by smearing and treating skins designed for the saddle, the book-binder, etc.; in short, these essential oils, oil of cedar, and the like, not only prevent mildew and other fungi, but are known to furnish a large and constant supply of ozone—nature's universal disinfectant and conservator of health—but they also render all fabrics, fumigated, painted, varnished, or in any wise saturated, nearly as durable as the original source whence derived; hence their time-honored repute, and they are still used in Russia and elsewhere, as before observed, for preserving leather, skins, feathers, etc., from decay, mildew, etc.

All birches, together with our own, have long, lithy, delicate twigs, and for aught we know to the contrary, might still be used, as of yore, for juvenile disciplinary purposes. "Bhoorja," the ancient Sanscrit name for an Asiatic species, is by some considered the probable primitive origin of our word "birch."(?) "Book" is from beechen bark, and birch-bark. As usual, with many other trees, when wounded or badly attacked by insects, the normally arrested growth flies off into a set of petty erratic spangles of irresolute twigs known and designated by the Scotch as "witches' knots."

Birches, in general, may be said to express feminine elegance in form, and with the wind merrily at play among the branches, vivacity in action, if so be the foliage sufficiently abounds to redeem them from trenching too closely upon the trivial; but as we usually behold them, when the brightly varnished leaves glitter and sparkle the air with living diamonds, and the gentle zephyrs murmur milder music among the birches, there is a sense of cheery glee not easily described which appeals to the sense of sight and sound, and is greatly enhanced by the spicy aroma that so often perceptively exhilarates the inspiration. And when the final farewell Autumn airs come down from their high abodes upon the mount, and begin to sigh their sad adieu over all the glen, the birches don their bright rich creamy mantles and gleam and glow along the mountain vales, every one in his own rank—banners joyfully flying—the closing scene is one altogether charming.

CALIFORNIA WALNUT.

(*Juglans Californica.*)

* * * "Mighty trees—
In many a lazy syllable repeating
Their old poetic legends to the wind."
—*Longfellow.*

This tree, like its congeners, is rather deep than heavy foliaged; more clouded and graceful than the grosser English Walnut (*J. regia*); not so heavy as the great Black Walnut of the West (*J. nigra*), nor so open, light, and airy as the White Butternut of the eastern United States (*J. cinerea*).

The California Walnut forms a very handsome soft velveted tree, often in age lightly clouded, usually rather symmetrical, with rounded head, not so much storied and tiered, but an exceedingly quiet harmonious tree in its native haunts, or in the vicinity of buildings, along road-sides, in parks or lining avenues; from sixty to seventy-five feet high, about two to four feet in diameter; the dark bark thick water-line furrowed; branches duller gray and never smooth, or only traced and slightly marked where these channels are to be later on in life. The large compound leaves, a foot to a foot and a half long, composed of eight or nine (rarely more) pairs of leaflets terminated by an odd strictly lance-shaped one, the other eighteen or more lanceolate-ovate with a sharp elongated point, sharply toothed on the margin, about three inches long. The softened light yellowish-green hue of the foliage is very pleasing to the eye, and its sober contrast with other sharper and more sprightly trees, during the Summer and Autumn months, produces a fine effect. The tree well expresses elegant dignity, but we have never met with it of such proportions as to warrant the title majestic, in a comparative California sense.

This graceful Summer-green tree is mantled like the "Oriental Tree of Heaven" (*Ailantus*), only more delicately, and equally velvety. In general outline it is somewhat oblong, or about twice the height of its breadth. This long leafage is exceedingly lovely, whether admired as to particular leaflet or compounded leaf, or the general flossy masses umbreling twigs, and everywhere preserving their curves and the great crowning line of beauty that domes the top. So, also, in every motion, waving to the wind, from the least leaflet to the greater leaf and greatest mass thereof, ever responsive, as it were, with moving tongues of love; for the foliage is by far more yielding than the willows by the brooks with which they congregate, bending in pliant loveliest grace—no rustle, no murmur, quiet as a lamb—fascinating and gentle as the dove of the dawn, or enrapt in ecstatic flight, their wings kissing each other, as saith the prophet. The blossoms tassel the tips of the twigs with long ornamental catkins, two to four inches in length; the fertile females are in a small terminal group or solitary.

The spherical fruit, like other walnuts noted, consists of an undivided husk, from one and a half to two inches in diameter, which gradually decays, after falling, leaving a roundish nut somewhat variable in size, form spheroidal, shell thick and very hard indeed, kernel of sweet nutty fine flavor, surface so slightly vein-channeled, or rather marked, as to be nearly smooth; the meat is thick, broadly and evenly wing-lobed, covered with a dark pellicle of skin; the size and form of the nut varies, say from one and three fourths to less than an inch in diameter. This extreme thickness and hardness of shell preserves the vitality of the nuts for many years. Were they securely stored by squirrels and gophers—or "topers," as the right title is—they would, if kept perfectly cool and dry, last for ages; at least no nut-producing tree with which we are acquainted preserves the perfect plumpness, softness, and sweetness of the kernel like the California Walnut. Should a thinner shell be deemed advisable or desirable at any time, the male catkins can be cut away, in part, if not entirely, the moment they appear, or selections from seedlings which show most markedly a tendency by nature to a paucity of male plumes, and more feminine tenderness of shell, and propagate from those. At present we do not urge either its merits or future probable possibilities, as an edible nut of much economic value. It is, however, worthy to be borne in mind, that the *Prionus* already threatens the destruction of the imported English Walnut by boring the root base and poisoning the sap, so that they often die outright.*

* We saw these trees planted many years ago, and the barbarous chopping of roots may have been the real predisposing cause.

Therefore the inquiry may yet arise whether the native walnut has not vastly superior claims as a suitable stock for whip-grafting and wing-budding, etc., apart from evolutionary vigor, climatic adaptation, and a thousand and one other undeveloped reasons?

In favorable, deep, sweet, strong alluvial soils along creeks and the like, where it finds a good supply of underground moisture, this tree is of rapid growth, which it makes early in the season; its deep repressive shade greatly contributes to refreshing use, quite innocent of any harm often attributed to the continental walnuts, although they all exhale a strong aromatic odor, whenever the leaves are bruised or crushed; this natural exhalation is even given off on hot days so strongly as to be almost overpowering, and to some sensitive persons produces heaviness in the head.

Somewhat rare as this tree is—never abounding in groves—little is known relative to the value of the timber.

TREE POPPY.

(*Dendromecon rigidum.*)

"Sleep, gentle sleep, Nature's soft nurse."—*Shakspeare, Henry VIII.*

An evergreen shrub three to eight or ten feet high, one to three inches in diameter, with numerous slender branches, and whitish rather smooth bark; foliage yellowish-green hue, often slightly glaucous bloomy, the only woody plant of the Poppy Family (*Papaveraceæ*), and not long ago the world's wonder. Leaves variable from egg-shape acute to narrowly lance-like, one to three inches long, one half to two inches wide or so, mostly twisted on the leaf-stalk or turned up edgewise, surfaces roughened, nerves and veins prominent beneath, margins from rough to slightly toothed; the flowers on stalks one to four inches long, or sometimes set close down; the flower-cup of two sepals, petals or flower leaves usually four, when expanded the flower is one to three inches across; seed-vessel long linear, or attenuated upwards, nerved and slightly curved, and in general like those of the common California Poppy (*Escholtzia Californica*), one and one half to two and one half inches long; seeds globose, rough, pitted, etc. This beautiful Tree Poppy often branches low in the Sierras, and spreads so profusely in favorable localities as to become a massive clumpy shrub, brilliantly ornamented, so decked is it with a succession of even brighter than lemon yellow poppy-like blossoms throughout the Summer and Fall seasons, often, near the coast and south, far into Winter and even to the opening Spring of the following year; in these last localities, and on adjacent islands, perhaps there is no season in California when these flowers may not be found more or less abundantly. The very thrifty condition of this shrub, as seen now and then, shows its wonderful capacity for improvement by judicious culture. To ensure success in this enterprise, it is important to observe that, in order to preserve the precarious vitality of the seed, they require immediate planting, or deposition in dry, ashy, sandstone soil, and yellow or white loam with magnesian debris, if possible; they require an ardent sun, little water, save underground moisture in absolutely sweet drainage.

MOUNTAIN MAHOGANY—TWO SPECIES.

(*Cercocarpus parvifolius and ledifolius.*)

* * * "her hair
Is like the Summer tresses of the trees."
—*Longfellow.*

Although the evergreen Mountain Mahogany may be considered as a large shrub, for in this character most of the species mainly abound, yet they are frequently found six inches to two feet or more in diameter, thirty to fifty feet high, furnishing large timber-logs, eight to twelve feet in length, or sometimes more, the smaller end nearly or quite a foot through; the bark brown and shaggy, or somewhat scaly. The largest species (*C. ledifolius*) is mainly, if not quite entirely, confined to the Eastern arid slopes of the Sierra Nevada. This has more the aspect of a depauperated apple tree—if, indeed, the leaves are not too small for the comparison—giving it an air of littleness not altogether agreeable to an artistic eye. Nevertheless, it sometimes becomes a tolerably handsome tree, forty to fifty feet high by two and a half in diameter; leaves thick and leathery, one half to one and a half inches long, one fourth to one half inch wide, lance-like, rough netted, and nearly naked above, margins entire, and the edges rolled back, dark green and shining, but very short close-woolly beneath, mid-rib prominent on the under side, veins obscure; flowers nearly stemless; fruit-tails about two to three inches long, spirally flourishing its pretty plumes, after the manner of the genus. In this, the flowers are from two to six together, nearly close set down in the leaf-forks. Furnishes the hardest, heaviest, and best wood in the United States, if not on the North American Continent, unless we except the Lignum Vitæ (*Guiacum*), one species in Texas, the other on the Isthmus, which are all that are known to me. The wood is similar in color, dark, almost black mahogany, and takes the fine polish of ebony, and may be used by the wood engraver.

The wood readily sinks in water, as the first cuts of some other trees are wont to do. "As fuel it is worth thirty per per cent. more than hickory, the specific gravity of that being .838, while this is 1.117; the ash .52 of one per cent., hickory .81—or three tenths per cent. more." Tables and other furniture have been made of it, but unless properly treated, *i. e.*, by steam, swamp-buried, or mineral spring-bathed, and then slowly seasoned, would be likely to season-crack, etc., as almost any other wood is apt to do when rudely treated. For mauls and mallets, rollers and boxes for the heavy bearings of machinery, it lasts like metal and, although brittle, is much less so than lignum vitæ.

The tiny Birch-leaf Mountain Mahogany (*C. parvifolius*), of middle and western California, into the coast range of the Pacific, is rarely more than ten inches to a foot in diameter, twenty to thirty odd feet high. As these larger forms usually grow on or near river bars and banks, or creek borders, subject to periodical overflows, they are apt to be grazed and considerably damaged by repeated collisions of flood-wood, on one side; and from centuries of such exposures apt to be decayed. Sometimes these aged trees exhibit also the charred marks of forest fires; but, to a great extent, it abounds along in Summer-dried upland ravines, even on ridges and high mountain tops, where it becomes reduced to an unpretentious shrub. The little fan-folded and fan-formed leaves are entire and wedge-shaped at the base, feather-veined, toothed only above and at the blunt end, set rather close to the stem in sociable proximity, frequently smooth, often slightly varnished above, lighter and downy beneath. The general effect of the foliage is that of a soft sea-green, or hazy hue, which is greatly enhanced when the very numerous straight, silky tails of the seed, two to four inches long, at first prudishly close-pressed, at length, towards maturity, begin to spirally coil and spread their tiny plumes as softly as the beautiful Smoke Tree. The flowers are rather inconspicuous, one or two of these cup-like and rayless, with fifteen to twenty-five stamens in two to three rows, set on the edge of this calyx-like or real calyx-cup, seen springing from the axil-forks of the leaves; in this last they stand on stalks one fourth to half an inch long, usually bent back. Flowers and fruits from May to July.

The wood, as before observed, is dark-colored, with very little sap, hard and prodigiously heavy, of exceeding slow growth, trees of the largest size being about one thousand years old, perfectly sound, without infirmity, journeying on with eons unnumbered crowning their venerable brow, and others yet in store; still the beautiful tressed seeds come and go as of yore, prettily spiraling as in juvenile grace, merrily trilling to the breeze, silky softening into mellow haze her curly head, lest the unbecoming twig seem too strict and stiff, or formal and bare, to please the eye or satisfy the taste.

HIGHLAND LIVE OAK.

(*Quercus Wislizeni.*)

"The green abode of life."

This evergreen oak usually branches low, is rounded in outline, or erect, spreading, with the magnificent top rolling outwards; forty to seventy-five feet high, two to six feet in diameter, and relatively of less horizontal spreading habit than most other live oaks. Among the usual tortuous limbs, no dead nor decaying branch or twig is easily found, to such a remarkable extent does health and vigor everywhere abound. It is this very clean and neat expansion of prosperous growth above, black bark of the body below, and blackish bark of intermingled branches, together with that darkest, nay, almost black-green densely shadowing foliage, which so much tends to give an impressive and decided character to this tree. The bark on young trees, and thriftier branches of older ones, is more smoothish or even, a shade or two lighter, but always dark, shading to livid. This rough, black, or rarely gray-mixed body is somewhat less chinky than most oaks. Leaves thick, leathery, and rigid (rarely thinner), shining on both surfaces, the upper a vigorous dark green, lower, a shade lighter, inclining to yellowish-green; leaf stems slender, but not weak, usually less than one half inch long, blade flat, except in the young state, and prickly-toothed then, though mostly entire in age, per chance closely sharp-toothed on the same twig, egg-shape or oblong egg-form, sharp and awl-pointed, base obtuse or from blunt, rarely slightly heart-form or quite oval, or again, broad lance-like, seldom or never with jointed hairs in any stage, very short, starry, hairy, chiefly above, finely netted with translucent veins, nearly alike above and below—not that other oak leaves are not also more or less so, in some states of growth, yet, in this Highland Live Oak, always in a more prominent degree are they roughened and pitted, as it were, with this fine net-work. By this more distinctive and manifest texture of the leaf then, is the Highland (*Wislizeni*) Live Oak discriminated from Field, Cañon, Evergreen, White, and all other Live Oaks, so far as known; even where the casual forms are exactly alike. If any reliable measurements could be made, we should say the leaves were one to three inches long, and about half as wide, rarely less, save in the shrubby forms, however, extreme instances do occur where, in full grown trees, they are reduced to one quarter of an inch; or again, on the same tree, found four inches long by three wide, with every other form known to the querky gamut. The male tags starry-hairy; stamens, five to seven; anthers not cusp-pointed, as a rule; female styles, two to four or more, and long, as in the Black Oaks, to which section this belongs; acorns ovoid, long, acute, on short stems, mostly maturing in pairs the second year after setting, or rarely, one to five on a single stout stalk (peduncle), two or three of which mature, the others seldom attain to full size, one to one and a half inches long, one third to one half immersed in the cup, nut mealy at the sharpened top, to which the long recurve styles are still attached; indeed the length of these styles alone distinguishes it from the somewhat similar Cañon Live Oak. The cup scales are not very sharply lance-pointed, almost smooth, the margin slightly eye-lashed, flat and membraneous, rarely in some trees thickened or knobbed at the extreme base of the cup; color chestnut brown; both inside the cup and inside of the shell of the acorn soft velvety wooly.

These impassive oaks with their deep, dark, almost black-green pall of solemn foliage, as it were, night's sullen noon-shadows oversighted and left lonely on the landscape, would be too sombre if in extensive groves, even a minor song of sadness, if in any considerable groups; but as they are naturally and sparsely distributed here and there over the foothills and highlands, the effect is one of commanding dignity—forms the cleanest cut to the very verge of prudish precision—most distinctly defined against land or sky, or mid diffusive haze; and oft' the heated daze that shimmers the landscape of a long hot and dry season, far and near from lowland level to highland hill-top—then are these oaken bowers refreshing as the great shadowing rocks of a weary land; nor are they less sheltering at all seasons. We have seen some fine trees sixty to seventy-five feet high, with corresponding proportions, and spread hanging over homes and out-houses prove famous wind-breaks; arms akimbo, securely indifferent to the strongest blasts of the fiercest storms, even an ordinary whirlwind may wring no branch from his breast nor garland twig from his honored brow, or none that would leave any habitation at all behind; they stand, indeed, in the first rank of shelter trees. Of him may we well say as the poet sang:

> "How doth his patient strength the rude harsh wind
> Persuade to seem glad breaths of Summer breeze."

The timber is strong, tough, and very hard, withstands exposure and friction well, is used for wire-cable rollers of steam elevator-cars, and where divers mechanical uses require the best combined qualities; yet people from abroad are wont to report that "a passable wagon wheel cannot be made of California wood, nor a really good one in Oregon." Reëchoed assertions like these are, among those hasty conclusions, we hope to show, not warranted by either careful inquiry or personal observation. Most likely the complaint does not originate from wood on the spleen, or we should be hopeless; only a trivial overweening weakness, but nevertheless it reminds us of the wagon-trials of a wealthy planter of Newton County, Georgia, who kept his teams hauling all the year round from Augusta, to and fro, and was greatly annoyed at the sun-cracking and general failure to answer his purpose of various celebrated eastern and northern timbers. In a fit of desperation he betook to his own woods, cut a Water Oak (*Q. aquatica*), reputed among the poorest oaks, treated it according to his own ideas of fairness, *i. e.*, cutting in dormant state of sap, etc., thorough water-soaking and subsequent slow seasoning; in short, had his own running-gear made and put on the line of summer and winter hauling, and it lasted over thirty years. Duly to appreciate such a test one should be acquainted with the red and black mire and clay roads of that section, the like of which are rarely seen on this earth. Hearing of this we took particular pains to go and see him personally, and obtained a section of the felloe, which we brought to California and presented to the Academy of Sciences. Were not similar sweeping remarks rife on native fuels, it would be needless to say this oak makes first class firewood.

Rarely, a fungus (a *Dædalus*) has been known to attack this all-abounding, healthy, Highland Live Oak, entering scars where limbs are cut away, or natural knots in process of growth, not duly closed over; mycelium following the heart-fibres to those of the trunk and thence spreading up and down, making owl and squirrel-hollows; yet from great vital resistance the progress is slow, long remaining local; but for lasting and important purposes such tainted timber should be avoided.

The shrubby variety (*frutescens*) is common on the coast, and elsewhere; with much variation the leaves are similar, *i. e.*, at least always finely pit-net-veined on both sides, blade flat, smooth, and clean throughout, etc.; found throughout the State from near the southern boundary along the whole Coast Range, mainly in the hills and highlands and partly ascends the Sierra Nevada Mountains.

CALIFORNIA LAUREL OR BAY TREE.

(*Umbelularia* [*Oreodaphne or Laurus*] *Californica.*)

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* * * * "Gifted bards
Have ever loved the calm and quiet shades;
For them there was an eloquent voice in all
The sylvan pomp of woods." * * *
—*Longfellow.*

In the young state the California Bay Tree is of strictly erect habit; in rich, moist soils, with abundant room for display, as seen by mountain springs and margins of living streams, or larger rivers and favorite rural residences, it becomes a regal tree, sixty to one hundred and fifty feet high, four to six or seven feet or more in diameter; clean trunk twenty to eighty feet. The upwardly spreading top, densely branched in mature age, arches gracefully, and the long, slender, pendent boughs sway stilly as "phantom clouds with moving shadows o'er the meadow." But first, let us consider well some of the natural characteristics of this tree, that it furnish a better scientific basis for the artistic and the ideal, for even Pegasus' foot we know must touch the earth, high on the mount though it be, ere the immortal Nine sweetly sing by the fountains! On a nearer approach the universal yellowish-lucent, green-bronzy hue of the leaves and twigs strike you as peculiar, especially if seen in horizontal semi-translucent sunlight; altogether under the spell of its eververnal drapery, you naturally inquire why it is so still, serene, and congenial to revery, to poetry, and to song! Lo, too, the bosom of the great mother is always bare, here beneath her shade, however adorned she may be round about. No man is denied a welcome to rest on his laurels; no animal ever lacks shelter under her shadow, nor wandering bird a home in her boughs; so smooth, soft, and pliant are the deerskin-like leaves, they never rustle harshly, nor startle the listener by sudden commotion, as oak and other similar leaves are liable to do, for their voice is ever "low and still," and, living, dying, or dead, they continually exhale their exhilarating odors to purify and to sweeten the air around them. The form of leaf is exactly that of a lance; blade three to four inches long, from a half to one inch wide, leathery, arranged alternately; flowers and fruit in umbelules (*i. e.*, little umbels) at the twig tips—hence the generic name, *umbelularia;* also, a few flowers below in the axils of the leaves, which have solitary fruit. Ever blooming—as now in November, so in Spring, Summer, and Autumn—nevertheless they fruit in the Fall. Berries oval, about as large but scarcely as long as a French prune, or say one and a quarter to one and a half inches long by three fourths of an inch in diameter, greenish-yellow, or fully ripe and exposed to the sun, purplish; usually clustered in three to five, and at the end of twigs, sometimes solitary; in these, fatty matters abound with the oils, volatile and fixed. Pigs fattened on them yield lard more of the consistence of tallow. A kind of stearoptine, or camphor, is common to all the family of *Lauracæ*, whence the sanitary odor-sphere of this tree is truly wonderful—to some too exciting for toleration, even producing severe headaches, acting mainly on the posterior-passional part of the brain, as any one may satisfy themselves by the powerful sensation in the back part of the head, on deeply breathing over the bruised leaves. Agreeable as it is to our sense, few are found to bear the odor save at a distance. From the slightest collision, burnishing, or friction, these laurel leaves emit an extra amount of sweet, spicy odor; hence the name Spice Tree, and its use as a culinary substitute in early times.

The classic reader need scarcely be reminded of the renowned reputation of ancient Laurentia as a favorite resort of the feeble, and secure retreat from the pestilence, for there similar prophylactic laurels were the prevailing trees; besides, they have always been accredited with the quality of inspiring poetic ideas; hence the designation "Poet Laureat;" and for similar reasons it is, and forever will be, the immortal emblem and wreath for the brow of the brave, the gifted bard, and the perennial crown of the wise, for all the genuinely such are eminently in the affection of truths, and song is that affectional language of the soul.

This California Laurel is equally ornamental, if not far superior to the European Noble Laurel (*L. nobilis*). Of all the species ours is the most masterly imposing, very elegant and graceful evergreen tree. In briefly passing, let us lightly endeavor to see why; first, the foliage is not so tumuloid in separate outline, nor as a congeries of clouded masses, as in oaks and similar round-topped trees; nor is the top so prudishly exact to a line-pattern as are many of those. In these we have, with concurrent curves, a deeply thickened canopy, owing to numerous upright shoots in filling the crown thick with accumulated leaves, because adherent for several years, and so set very far back on the twigs; but this formal strictness is adequately complemented and duly graced in the outer pendent boughs. Are you alone or with a congenial companion, you may hourly watch the wind waves gently rolling over its yielding foliage, shimmering the lights and softening the shadows, until you heartily realize, in the words of the poet,

> "The glory that the wood receives
> At sunset, in its brazen leaves."

Though magic wands were formerly made from branches of these trees, there is some reason still for believing that there are more magic spells now in watching them wave so gracefully to and fro from the boughs; nor must we forget their invisible influences altogether, such as sanitary, brain, and nerve support, magical, poetical, and musical—the noble inspiriting base of wisdom and valor, with all its literary traditions, including the wreaths of the immortal Nine, with which they decked the brows of their favorites. In more recent times, the students who had taken their degrees at the universities are called Bachelors—from the French "*bachelier*," derived from the Latin *bacca laureus*, a laurel berry. As these students were not allowed to marry—lest the duties of husband and father interfere with their literary pursuits—hence, in time, all single men were called bachelors. "Speaking of rats," reminds us that the germinal end of the oblong nut of the fruit has, "for all the world," the perfect profile and markings of a rat's nose and mouth, and truly the old wood-rat himself is exceedingly fond of them.

Among the many uses already noted, the leaves of these salubrious bachelor trees have been used for making baywater. In early mining annals, also, condiments—when the usual were not, or scarce and high—then, withal, he flavored his meat and spiced his food; indeed, this tree is allied to the cinnamon, camphor, and other spice trees of commerce. The wood is remarkably hard and takes the finest polish; has eminent qualities that commend it where great toughness and elasticity are the requisites, *e. g.* no powder-mill timber, save this, ever comes out of those wonted tremendous explosions safe and sound; in short, it is quite unparalleled on this coast. No native wood has been more highly esteemed for cabinet work, and for the finest ship and other joinery and general ornamental purposes; for, in brief, it is preferred, from first to last, like its congeners of old, whether it be scepter for king, mace for judge, the shepherd's crook, or the old man's staff. That it has been carelessly cut and hastily worked, regardless of all antecedent customs and experiences of mankind, might be expected—the early Californian is probably not the only one known to career in a maelstrom of self-conceit or marvelous indifference to all the wisdom in the heavens above, earth beneath, and waters under the earth. Better be a little over scrupulous, as our fathers were, in the observance of times and seasons for cutting timber; waiving all cavil, in one universal voice it is agreed by common consent that timber, as a rule, should be cut in the dormant state of the sap, as the wood has then finished another greater ripened cycle, closed in and garnered the good—say from about the last of August and September, far into Fall, *i. e.* according to locality, whenever its closing growth season is, for then the timber is at its best. But if cut in its Spring or juvenile state, the timber is necessarily inferior, if not utterly worthless, for many reasons, but if for no other, because several insects, and especially the *Ptinus*, a little black beetle, bores and eats it up to a perfect powder-post within, with only an outer apple-of-Sodom shell left; great havoc is thus made of ceilings, bannisters, book-cases, and even books themselves, and indeed all kinds of furniture. Dr. Harkness informs me they swarm out, in Sacramento City, by myriads, on the fifteenth of May. In view of these facts, omissions, and commissions, alien to every axiom, ancient or modern, are we not justified in saying, that with this supreme indifference to the wisdom of mankind in all ages, it is fortunate no Delphic Temples are now built of bay, and dedicated to Apollo as of yore, or they would crumble to dust before the child then born were out of pantalets? Even heaven's own lightnings might be supposed to take some pity on such puerile and ephemeral proceedings, leaving it exempt and unscathed, as this timber has the reputation of being.

The Bay Tree, extending from Oregon throughout California into Mexico, of such wide and diversified range, must needs bear many local or common names, some of which are sufficiently complimentary and poetical, *e. g.* "Balm of Heaven," applicable to those mainly within sounding echoes from off the peaceful shores; farther back and far south on more burning exposures, reduced to a bush, the odor is too rank and disagreeable, might then well carry another name—the famous "Pepper Bush," etc.

BOX ELDER, OR ASH-LEAVED MAPLE.

(*Acer negundo.*)

"Go mark in meditative mood where Autumn
Steals o'er his woods with mellowing touch like time—
'Tis a scene
That o'er us sheds the mild and musing calm of wisdom."
—*Anon.*

A handsome rather round-topped tree, with great wealth of soft, velvety foliage, constituting one of the densest shades known to California. A tree forty to seventy-five feet high, rarely over two feet in diameter; trees sixty by two feet are found in the vicinity of San Francisco, at Tamalpais; in Carson Cañon, forty by one and one half; at Corta Madera, Olema Creek, forty to fifty feet, and of great beauty. The Autumn foliage does not color so uniformly as other maples. After the fall of the leaf the sunlight is let freely in through its open and widely expanding branches, which then seem scattered, and the twigs rather sparse and heavy; its magic changes and bold contrasts between these respective states, are as wonderful as the wild walnut. The compound three foliate leaves are large, and like the young twigs very velvety; the separate leaflets nearly broadly egg-shaped, and somewhat three to five lobed, a little unequally coarsely cut-toothed on the margins above the entire broadly wedge-formed base—the lateral ones on very short leaf-stems, often only lobed on one side—the terminal odd one with much longer leaf-stem; these, with abundant drooping maple-like clusters of fruit, so deeply in-fill the top as with a pliant massive mantle of velvet, that few trees can equal the quiet, elegant, and dignified expression of the California Box Elder. These qualities, so manifest to all, render it one of the choicest and most desirable shades for rural adornment and road-side adaptation as avenue trees; hence, we find it held in high esteem by the public wherever available; the timber is soft and white; sap yielding sugar, a tree requiring a soil of some considerable moisture. On the coast south; this tree abounds, and in a few instances may be larger. A noteworthy fact of the instinct of the great gregarious butterfly (*Danais archippus*) is, that oft as the autumn air is filled with their living clouds, migrating to the happy isles beyond the Pacific floods, when those cold and torpid nights come down on their festive flights, they must needs roost and rest, for they can no longer fly, then myriads of them cling to the soft velvety leaves of the Ashen Maple for warmth, for solace, and for sleep. Is not their choice marvelous? And to behold them nightly return with the same regularity, for a time, as the pigeon or other wild birds. A jar, or club being thrown, they then fall helplessly down in showers of thousands, ere the sun revives them to active life again.

MISS DAVIS'S LEUCOTHOE HEATHER.

(*Leucothoe Davisii.*)

"Oh, happy pleasure! here to dwell
Beside thee in some heathy dell."
—*Wm. Wadsworth.*

A beautiful evergreen shrub, three to six feet high, nearly smooth, leaves alternate bright green or only a shade lighter below, thick, oblong, obtuse at both ends, or only the uppermost acutish-pointed, margins minutely toothed, leaf-stem short, blade about two inches long; flowers on long, one-sided racemes, and these in little fascicles of two to five or more in number, a terminal cluster adorning the tips of the twigs with an abundance of delicate, white, tubular bells gracefully nodding, all in a row along their respective common flower stems, to which they are articulated by a short thread of their own, bracts and bracteoles scale-like, etc., etc. Perhaps we may be deemed too particular, but this is seldom urged against a new discovery, much less one so desirable for cultivation. To the hypercritical and fastidious these flowers might be considered too coquettishly pursed at the mouth, and a little pouting; but they are fragrant and decidedly pretty. The honey from some flowers of an allied kind brings on intoxication of a formidable phrenic kind of very lengthened duration, and most of their relations have a heady tendency, to say the least; but little is as yet known of this species, and the fruit is altogether unknown.

Collected by Miss N. J. Davis, of Plumas County, found in the high Sierras, north.

PIPSISSEWA.

(*Chimaphila umbellata and Menziesii.*)

"Thy sports, thy wanders when a child,
Were ever in the sylvan wild."—*Bryant.*

A low winter-green shrublet, with long creeping half-underground shoots, sending up-curving stems here and there a span to a foot high; the tufted leaves reverse-lanced, or the base wedge-form, margins sharply and slightly saw-toothed above, these whirls paired or somewhat scattered, very dark varnished-green above, and not at all spotted, light green beneath, the single naked flower-stem from the top supporting a cluster of fragrant flowers, white or blushing, consisting of five concave petals or floral leaves in a wheel-form; anthers, ten, yellow or purple, on woolly threads or filaments, arranged in a more or less umbeled order. A very pretty plant, but can only be cultivated in damp, shady, well sheltered, mossy, or leafy-mulched places. Highly valued as medicine; all parts used for tea in a great variety of complaints, as tonic, diuretic, etc., and also externally. Why it should be called Prince's, or anybody else's, Pine, requires no small amount of imagination to conjure this humble creeper into any remote similitude, unless it is found in the very dark green tufts of confused foliage, seen in the most general twilight perception of the inattentive rustic, or from a like ancient state that gave the name "grass" to mean everything green. A thousand lifelong associations throng around these ever-refreshing wood nymphs, numberless and ceaseless as the waves of the great Pacific Sea, that soothes to silence and to contemplation.

Found in hilly woodlands, for the most part, chiefly under the shade of coniferous trees, or mixed with oaks; Mendocino County, and north around to Mount Shasta region and Sierra Valley.

The *C. Menziesii*, also, is a charming foliage plant of variegated white mottled leaves, hence called the Spotted Wintergreen; about a span high; leaves mostly broad, egg-shape, two, two and a half, or three inches long, about half as broad, often more or less purple beneath; most strikingly resembles the Eastern *C. maculata* and the recently discovered Japanese *C. Japonica;* fruit somewhat wheel-shaped, five-lobed and celled. Found in similar sweet forests, often together, as companions.

AMERICAN ASPEN.

(*Populus tremuloides; correctly, tremuliformis.*)

———"When zephyrs wake
The aspen's trembling leaves must shake."—*Johnson.*

This is usually a small tree of thirty to fifty feet, but in some of our alluvial bottoms and borders of lakes, abounding in groves, it rises to seventy-five or one hundred, always with a relatively small diameter of one to two feet in California; but in the Valley of the Mississippi River, trees four feet in diameter and two hundred feet high are known. This tree is always neat as a belle in her teens; the body slender, and apparently perfectly cylindroid; smooth and soft as if just bound in Russia leather, of whitish-clayey, or semi-sober pea-green bark; the branches also are slender and small; the bark on their upper surface becoming lighter colored, which reflects the light afar, and renders these trees conspicuous objects at a great distance, and more especially in their bright yellow Autumn dress. The young shoots are bright varnished, bronzy, brownish green, and the short twigs go off at broadened angles, which give ample space for the foliage, making the spray open and airy; the long buds sharp pointed, glossy, varnished with balsam, like all the poplars; leaves somewhat heart-circular in general outline; two inches or so long, and about equal in breadth; short, abruptly-pointed, slightly wavy-toothed and a little downy on the margin, supported on very slender, long leaf-stalks; laterally compressed, or thinly flattened at, and less so, far back from the blade contrariwise; and thus weakened, to any breadth-wise, horizontal impulse, they fluctuate and flutter, or rock as lightly and prettily as any wavelets with their breezy lights and shadows o'er the mirrored lake; to the beholder it seems a ceaseless wonder how these leaves can be so sensitively responsive to the most trivial zephyr, even when all else around is still, save their own cupiditative prattle to the passive ear; and to the eye, as ever, glinting the light of truth above the trembling shades; as sparkling wit is wont to "drive dull care away," with all her approaching gloomy shadows, yet can we not discern, alternating coyly, the humorous, the festive, and the foolish withal? Let not the sage nor serious, forever hearken to hear some portentous "going in the tops of the aspens;" nor are these emblem leaves of the literati and the poets altogether so frivolous as some of them suppose, and many more apt to take for granted as manifestly apparent; for thus they earnestly renew their life, and do continually go to enliven the groves, and the hearts of all in sympathy with them, and their likeness. This ever restless, not to say unstable motion, is common to all the poplars, and some of the *populars*—with the birches—but in none is it so characteristic, as in this *tremuliformis.* We have not alluded to the tiny infantile, silky side stipules which fall off; but the flowers and fruit are more important. The male catkin tassels are two inches or more long, with deep crimson stamens in clusters on notched scales fringed with hairs. The female fertile tassels are also very hairy, studded with crimson stigmas conspicuously prominent from their own prettily curved or pending tags, becoming elongated as they ripen, in May, to three or four inches.

The wood is soft light and white, fine grained, and sand papers and burnishes well, but quickly perishes on exposure to weather. Is deficient in strength, especially in lateral strain, but is nevertheless applicable to many uses. Such woods that are so neat, never splinter, seldom season-crack, and though laterally weak, do not usually split with nails, etc., are apt to be too flippantly scandalized. It must be borne in mind, that the caprices of fashion, so often deprecated, still rule the world, and the novel demands of the arts, and constantly increasing inventions, may at any moment, in a thousand ways, cause these to spring into notoriety, and transiently outstrip the more durable in demand, as in quality. This vacillation of value may be as unreasonable as some of the fashionable people that have most use for the article, or the demand prove as fickle as the foliage, or those whom the masculine poets have wantonly likened thereunto. It is already reported to be ground into pulp for paper for casks and a thousand uses, and by the discovery of a cheap vitreous or lackered varnish, etc., our old current ideas of the value of these soft white and light woods in general, might entirely vanish away. The bitter bark is a valuable tonic, like quinine; but the balsamic spring buds as a tea, with a little borax the size of a pea, restores the enfeebled languid state and capricious appetites of Spring in a wonderful degree.

Found throughout California and the coast generally, abounds mostly at about six thousand feet to ten thousand, of Sierras and corresponding thermals.

Notes on Hydraulic Mining.

By F. W. ROBINSON.

NOTES ON HYDRAULIC MINING.

It is known that the debris from hydraulic mines, that accumulates in the lower cañons, always contains gold. It proves that the hydraulic process, as observed, is defective, and is probably more wasteful and results in a greater proportionate loss of gold than any other adopted process for extracting that metal from its surroundings.

Unlike quartz, or any other substance of a homogeneous nature in which gold may be found, where the gold is measurably equally distributed throughout its matrix, it is very unequally distributed in auriferous gravel deposits. A stratum of gravel may be very rich, as ascertained from an average of many month's washing, and still show as comparatively barren when tested in small quantities of a supposed average quality. Some of the strata are totally barren and some nearly so. The barren strata, in a series of months, may prove to be a large and serious proportion of the total quantity of the material worked; and in another series, the proportion may be very sensibly diminished, since all the material encountered must be removed, save the bowlders.

Again, the gold found in a given quantity of gravel is not an index of a greater, a less, or an equal quantity of gold being present in another equal quantity of gravel of the same appearance. A hundred "colors" found in the one instance may not equal in value a single flake found in another. The pan simply proves the presence of gold in greater or less profusion in the small quantity of gravel tested, and to this extent it is an indication only of there being more gold in the bank or stratum from which the gravel comes. The next and each succeeding pan, will show greater or less amounts of gold, no two alike, with wide differences, and it is likely some pans will show no color. But neither in the aggregate of such tests nor the average, nor separately, can fifty or a hundred pans of gold bearing gravel compare in approximate accuracy with the assay of an ounce of the average of a yard of gold bearing quartz, as affecting the probabilities of the yield of the whole deposit.

The pan, also, shows marked peculiarities in the characteristics of the gold taken from the different strata. It also demonstrates that the so called "pipe clay" strata are barren of free visible gold. It will demonstrate that a given stratum probably contains more or less of free visible gold than another. It is a test depending upon the keenness of vision, unassisted, for its value. A particle of gold imperceptible to the eye from any cause loses its tally. If attached to, or surrounded by another substance, its own gravity is so completely absorbed in the lesser quantity of the other that its identity is entirely lost and eludes capture. Then, when a pan of gravel is washed it may not develop a color, when it may have contained many particles not discernible to the naked eye, and thrown aside. The pan will indicate the presence, in the bank, of gold bearing materials (soluble in water), very little of which is saved.

The amount or proportion of gold lost cannot be definitely determined, because there is no known process of accurate assay of a gravel deposit:

(*a*) That is known to be lost which is known to exist in the gravel and is known not to have been saved.

(*b*) Gold is found in the tailings which must have come from the gravel banks, and passed through the flumes.

These two propositions must be intimately connected, and each must, perforce, explain the other.

That the black magnetic sands carry with them, physically attached, large quantities of gold, forming an appreciable portion of the whole value of the mass of auriferous gravel that may have hitherto been allowed to mostly run to waste; that by reason of their comparatively high specific gravity it is practicable to save them, is admitted by many practical hydraulic miners familiar with the subject, and is the object to be attained.

Admitting that by means of improved appliances these sands, and also to a great extent fugitive gold particles, can be saved, a vehicle presents itself in every gold gravel bank that carries to the dump untold treasures.

A free particle of gold large enough to be perceptible to the unassisted eye and clean enough to be susceptible of amalgamation, cannot possibly escape in an ordinary hydraulic flume of reasonable length. If it be heavy enough to resist the tendency of the water to keep it suspended, it will seek, and must find and retain, the position assigned to it by its gravity. But if it be not clean, it will not amalgamate with quicksilver, although brought in contact with it. It becomes an isolated particle, without affinity for any other substance, and slowly, but surely, it will find its way to the dump.

Gold particles, singly or in numbers, may be physically attached to or surrounded by a substance having a compounded specific gravity of 3 or 4. So that if the gold particle having a specific gravity of 18 should be attached to or surrounded by another particle with a specific gravity of 3 or 4, it is evident that the gold cannot assert its own untrammelled gravity in seeking a state of rest.

In cemented or conglomerate gravel that requires blasting, the gold is saved simply by violent disruption from the surrounding material. It is idle to suppose that a complete and thorough separation can be accomplished in this way. Nothing but a grinder or a pestle can produce this result, leaving then a certain portion of the gold particles that will not amalgamate with quicksilver.

It is known that the tailings from the hydraulic mines that fill the lower cañons contain gold. Each particle of this mass has passed over and through thousands of feet of flumes, tunnels, and undercurrents; and yet there is found mingled with it notable quantities of gold particles, of such size and shape as to preclude the possibility of their ever having been attached to grains of black sand (very rarely can gold be seen attached to black sand without the aid of a glass). They are of palpable size and amalgamate readily. The inference is irresistible that they must have passed from the gravel banks over and through all the gold-saving appliances, and held imprisoned and carried captive in walls that had not yet been broken by disintegration through the aid of exposure to air, water, sun, and ever varying temperatures through a considerable length of time, and their surfaces cleansed by the same agencies.

Hydraulic miners know this and acknowledge it, and they allow the gravel to remain unwashed as long as possible after being blasted or felled; but it is in the nature of their mode of operations, that no long time can elapse before the gravel is washed into the flumes. If at this moment it is not completely disintegrated it has but a few hours in which to become so before it is cast to the dump. Here, in the course of time, proper disintegration naturally ensues. Even if gold is released in the passage of the gravel through the flumes, by attrition, it may not be in a fit condition for amalgamation.

To say that the gold had been released completely, though the matrix had been for a longer time exposed to the action of the air, water, and varying temperatures, is assuming a result not justified by experience. The process of treating kindred and similar gold-bearing matter by direct exposure to sun and air, with frequent wetting and stirring, requires weeks and months before the gold is so far liberated and cleansed as to be susceptible of amalgamation with quicksilver.

Kustel (1880, p. 56,) says: "It is not decided whether gold in sulphurets exists in a metallic condition finely impregnated, or whether it is, like the iron of the pyrites, chemically combined with the sulphur. * * * There are sulphurets in California assaying one thousand two hundred dollars and more per ton, and they may be ground to the very finest slum; but no free gold, or only a very little, will be visible under a good microscope. This seems to confirm the theory of a chemical combination much more than the presence of some particles of free gold after a finer trituration, which proves only that free gold is in sulphurets, but not that there is no chemical combination besides the free gold."

There may be, then, gold in an auriferous gravel bank, in such a condition that it cannot possibly be secured by the ordinary hydraulic process.

Suppose that the width, depth, and direction of a gold bearing gravel channel of indefinite length should be known, and that, by a local earthquake or volcanic eruption it should be upheaved, broken, and shattered throughout its whole extent as completely as it could be done by man with the aid of explosives. Then suppose that copious rains should fall upon it until it were well saturated; then a proper interval of no rain, to be followed again by rain, thus alternating for months, or a year, or years. One acquainted with the economies, features, and requirements of hydraulic mining, would, undoubtedly, say that the ground would be in the best practicable condition for mining, or washing, and that the longer it remained subject to such conditions, the more economically it could be worked, with every probability of a much larger yield of gold than though the earth were washed when comparatively fresh from the face of the bank.

A shaft sunk to the bedrock at a proper point within the side limits of the channel (and at such a distance from the face of the bank being worked as to preclude all possibility of being interfered with by the working operations), would admit of the running of main and lateral powder drifts, in any number, radiating in any desired direction and for any desired distance, including the whole width of the channel if desirable, and no more than might be desirable. This shaft, with the drifts, would afford valuable information regarding the hitherto unexplored ground, viz: the thickness and character of the various deposits, the course and width of the channel, the dip of the bedrock, and other items, including, perhaps, the discovery of other diverging gravel channels.

Such a shaft would be the point of convergence of any number of powder drifts of any practicable length, and at the same time explore an area, at bedrock, of a hundred acres, more or less. The comparative effects of a number of blasts exploded simultaneously over a like number fired in detail, are so well known as to need no comment here. A large number of properly apportioned mines, distributed under a large area, discharged at the same moment of time, would, of course, cause an upheaval and shattering of the closely compacted resisting mass. The shattering effect upon the gold matrices would also be more pronounced in the lower strata than in the ordinary bank blast, by reason of the superincumbent weight. The lines of least resistance would always be vertical.

The actual cost of the preparation for a blast of this proposed magnitude would be greater than the cost of ordinary drifts for exploding the same quantity of powder in occasional blasts, and at lengthy intervals. But if the cost of each should be equated to the cost per cubic yard of the material that would be upheaved and shattered, it is probable the difference would be favorable to the more comprehensive plan, perhaps to the extent of defraying the interest upon the whole cost for a few years, or until such time as it might be utilized.

The additional preliminary expenses per lineal foot of drifts would consist of cost of the shaft, the cost of hoisting and of forcing air into the drifts, and the use or depreciation of the engine, or hurdy gurdy, and plant. The latter would be used for the same purpose in the future. To this should be added the interest upon the whole cost of the above, together with the interest upon the cost of the large amount of powder required for the purpose, which should be for not less than two or three years.

These are not very serious expenses to contemplate, in view of the great prospective benefits and advantages to be derived from it, and also of the probability that the increased quantity of material that will be upheaved because of the great number of drifts and simultaneous explosions, will more than compensate for the additional cost.

The great mass thus shattered and broken, would be the contents of a huge leach tub with a filter at the bottom. The lower and more valuable strata have remained for thousands of years with absolutely no change of position or temperature. The admission of running water from time to time upon the shattered, but hitherto motionless and heavily compressed deposits, will impart its caloric to the mass, thus inducing motion in its particles, a process of disintegration. And, if sufficient time be given it, with alternate exposure to air and water, the material that now passes through the flumes holding gold captive, will set it free before it enters the flumes. Then, the blasting can and should be done years in advance of the piping. It will change all the material into the best possible condition for working.

It would be profitable to consider the possible effects the gases from the explosions may have upon the gold particles. They may so far tarnish them as to render them unfit for amalgamation. That sulphurous gases may have this effect is highly probable.

The separation of particles of gold from the earth through which they are mingled, by the so-called hydraulic processes, is based upon the action of water in motion upon bodies of different specific gravities.

The specific gravity of gold being approximately 20, and that of ordinary sand and gravel, say, 2½, a current of water passing over and disturbing the sand containing gold and other substances of a specific gravity measurably greater than the sand, would have a tendency to wash away the lighter portion of the mass, leaving the heavier behind. This result is conditional upon a proper velocity of water. (See NOTE A.)

It is evident that a sufficient velocity of water would be required to put the sand in motion, but not so great as to cause an unsafe movement of the heavier particles. It is evident that a velocity of water sufficient to move a particle of gold, the equivalent of the volume or weight of which might be 1, would keep in dangerous motion another particle of gold, the volume or weight of which might .1 or .01. (See NOTE B.)

The ratio of the area of the surface of a body to its weight or solidity, is of course, less in large than in small bodies. Thus, certain particles of gold with a given velocity of water would arrive at and retain a condition of rest, while other particles with the same velocity of water and the same specific gravity, but of smaller size or different shape, would be kept in constant motion. (See NOTE C.)

Gold particles are very frequently coated with some foreign substance, that prevents alike subsidence and amalgamation. It is not

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NOTE A.—The primary principle involved in securing gold by the hydraulic process is that of gravitation, proceeding upon the supposition that gold, being of a higher specific gravity than any substance with which it may be mingled, will be precipitated upon the bottom of the flume, and there coming into contact with quicksilver, will be coated with it. And one particle thus coated adhering to others similarly coated, a cohesive mass of particles is finally formed, presenting a more or less proportionate area to the force of water in motion, than any portion of it if subdivided. Any influence tending to prevent the precipitation, operates, to that extent. to defeat the process.

As the observance of but one condition is necessary to insure amalgamation, the non-observance of that condition will prevent it. If no quicksilver were used in the flume, but very little gold would be saved. If the gold particles cannot come into contact with the quicksilver, the same result will follow.

NOTE B.—A cube, the side of which is 1, its contents = 1, and its sides 6; being in the proportion of one of volume to six of surface.

Assuming the shapes of gold particles to be cubes, and the extremes of their dimensions to be one fiftieth of one inch for the sides of the largest, and one thousandth of an inch for the smallest, we can get an idea of the relative forces applied to gold particles of different sizes in the flume with a constant velocity of water, and thus infer the different effects upon particles of greater extremes in sizes.

Substituting weight for contents, the ratio, as between the surface and the weight of the two above named particles, is as 1 to 200. Thus, in proportion to its weight, the smaller particle has to encounter a relative motive force two hundred fold greater than the larger one.

NOTE C.—Every hydraulic miner knows the difficulty, if not the almost impossibility, of capturing the fugitive gold particles—those that refuse to amalgamate. They may be seen by the thousand in the ground sluices and flumes during a clean-up, when the water is very shallow and clean. They will glide along near the bottom of the flume in long streaks, and as soon as they meet a body of sand, are lost to view. It will be observed that they move with marked varying rapidity. It is probable that they do not come into contact with the bottom of the flume, owing to the interposing atoms of water and the inadequacy of the weight of the gold particles as compared to the surface exposed to displace them, thus keeping the gold particles in constant motion. Were the surfaces of these particles clean, they would sink and amalgamate; but, being coated with some light substance, they cannot assert their own gravity, and are kept in constant motion. If they come in contact with quicksilver, they cannot amalgamate.

improbable that the specific gravity of a minute particle of gold thus coated or filmed, might be reduced to 7, or perhaps less, as a compound body. (See NOTE D.)

Thus it would be impossible for such a gold particle to subside with the same velocity of water that would barely admit of the subsidence of a clean particle of the same size. A piece of gold of considerable size is also in danger of being carried away, not by the direct action of the water, but by the movement of the mass of sand with which it may be surrounded; and, unless it meets with an actual obstruction in the flume, it is very likely to be carried to the dump and lost. (See NOTE E.)

Where the gravel bank is so hard that the water jet will not readily cut it away, recourse is had to blasting. It is well known that gold-bearing gravel that has been exposed to the action of air and water for a considerable length of time, surrenders its treasures with much greater willingness than where the earth has been worked fresh from the bank.

In bank blasting, the earth that has been upheaved and shattered is ordinarily worked into the flumes at the earliest practicable moment. Sufficient time is not allowed it to be acted upon by the combined influences of water and air.

Minute particles of gold are held in physical contact with larger bodies of some other material, the specific gravity of which may not be more than 2½ or 3½. It is washed into the flume before disintegration can take place; in a few minutes, or an hour, it is in the dump, where it undergoes the process it should have been subjected to before entering the flume. The non-disintegration of a considerable portion of a hard gravel bank, or one that requires blasting, is the cause of one great loss that is known to be sustained in hydraulic mining. (See NOTE F.)

NOTE D.—It would appear that but one condition must be observed in order to assure amalgamation of gold with quicksilver. It is, that the actual surface of the gold should come into contact with the quicksilver. Any film or coating, however thin, upon the surface of either, will prevent their contact, and prevent amalgamation.

NOTE E.—A particle of gold, the moment it enters the flume, is hurried along regardless of its peculiarities, whether they be favorable or unfavorable for precipitation and amalgamation. The gold not gathered in the flume is supposed to be arrested on a long, wide table, with an inclination or grade much greater than that of the main flumes. By means of a gridiron arrangement of iron bars in the bottom of the flume, a partial separation is made of the coarser from the finer, smaller portions of the debris, the former going directly to waste, and the latter, with enough water, dropping through the screen, or "grizzly," falls upon the undercurrent table and spreads out over its whole width, the water being about half an inch in depth. Over a system of these tables, it is conducted, by the water, from one to another until the gold is supposed to be wholly eliminated. The fact of gold being collected on this table, or undercurrent, is a proof that the particles, of different qualities as regards density, form, and cleanliness, require different treatment to bring them to a state of rest.

Particles of gold have no molecular attraction for each other. Particles of quicksilver, unless they are very finely separated, have a strong molecular attraction for each other, the resultant of which is a limited degree of cohesion. The particles of clean gold, having an affinity for quicksilver, and being covered with a film of it, are, for the purpose, virtually converted into particles of quicksilver, and it is the molecular attraction of the particles for each other that causes the aggregation of millions of them into a mass called amalgam.

NOTE F.—It is known that, under certain conditions, gold particles have no affinity whatever for quicksilver. They may be placed together in a vial of water, and shaken for any length of time, and no amalgamation will take place. The apparent antagonism is explained by experiment. If these gold particles are placed in water moderately heated, and quicksilver be then added, amalgamation will ensue. Or, if the quicksilver be heated, the same effect will be produced. If the gold particles be immersed in dilute sulphuric acid, they will be fitted for instant and perfect amalgamation. This will prove that they are coated with some substance that prevents contact between the clean surfaces and the quicksilver. This removed, amalgamation readily ensues.

It is entirely practicable to submit all the material to a process of complete disintegration before it enters the flume, and reduce it to such a condition that it will, of necessity, yield all of its heavier portions. It is possible that the gases arising from the blasting operations may so tarnish the surfaces of the gold particles as to render them, for the time being, non-susceptible to amalgamation with quicksilver; for, in order to assure amalgamation, it is essential that the actual gold surfaces should come into actual contact with the quicksilver.

Whatever the products of the combustion of the explosives may be, they are probably not insoluble in water, and alternate exposure to the influences of water and air would cleanse the gold particles from powder contamination.

Aside from rocks and bowlders, the gravel banks contain a white clay, ordinary sand, and gravel, with a specific gravity of 2½; black magnetic sand, with a specific gravity of about 5; hybrid sulphurets, with specific gravity of 6 to 7, and some gold, specific gravity of, say 20.

There is such a marked difference between the specific gravity of any two of the above that, with proper appliances, they should be easily and perfectly separated.

The proportion of black sand contained in a gravel bank can only be estimated or guessed at, it has never been determined with any close degree of accuracy; no especial device has been successful in saving it. It is known to contain large values in gold, ranging from one thousand dollars to two thousand dollars per ton. Estimates of the proportion of black sand in quantity vary from one half to one twentieth of one per cent.

An estimated low average value of one thousand dollars per ton, and even one fiftieth of one per cent. of the whole deposit in quantity would make twenty cents per ton of the whole quantity of earth washed that goes to waste in the black sand alone.

The gold is physically attached to the surface of the sand-grain. It is very seldom apparent to the unassisted eye, and not readily found even with the aid of an ordinary magnifying glass. With great patience, a grain of the sand with a particle, or perhaps two or three particles, may be mounted for microscopic use; then the gold appears as simply adhering to the surface of the sand-grain.

The so-called "concentrated tailings" are the heavier, semi-metallic, and hybrid sulphuret portions forming a small percentage of the whole deposit (perhaps, by estimate, from one to two per cent.), and carrying from forty dollars to sixty dollars per ton in gold. Their specific gravity is so high that they should be easily and completely separated from all the other deposits. The aggregate of this material passing to the dump with the great mass of debris must be very large.

Grave errors are being daily made in the present system of washing gravel, beginning with the first application of the water, the hurrying of the more indurated material into the flume before it is properly prepared, the too often overcrowding of the flume (resulting, perhaps, in a greater present yield of gold, but at the expense of a prodigal waste, and an unnecessarily rapid exhaustion of the gravel deposits); the non-observance of the laws and conditions that will admit of particles of certain forms, densities, and peculiarities, seeking and keeping a condition of rest, so that they may be controled. These varying peculiarities and characteristics of the heavier and more valuable portions of the deposits, must be consulted and their requirements satisfied, or they will, inevitably, run to loss and waste. (See NOTE G.)

NOTE G.—Irrespective of the weight, shape, size, specific gravity, cleanliness, peculiarities, or characteristics, the atomic particle of $\frac{1}{10000000}$ part of a cubic inch is subjected to the same heroic process as a piece of any size, and possessing all the attributes essential to subsidence and amalgamation. From the moment it enters the flume, if it does not observe the one condition essential to amalgamation, it has no opportunity for resting, but is hurried onward as though special facilities were provided for its flight, until it passes over the undercurrents and is lost in the dump.

By way of illustration—assume, for convenience, a spherical shaped gold particle, with a specific gravity of 20, and it is filmed with a substance having a specific gravity of 5; the gold particle (G.) $\frac{1}{5000}$ of an inch in diameter, and the film (F.) $\frac{1}{10000}$ of an inch thick.

The relative contents would be $\frac{F}{G}\ \frac{7}{1}$ and the relative areas of surfaces $\frac{F}{G}\ \frac{4}{1}$

Substituting gravity for contents, and applying values of specific gravities—

$$\begin{array}{lll} F & 7 \times 5 & = 35 \\ G & 1 \times 20 & = 20 \\ \hline & 8 & \quad 55 \div 8 = 6{,}875 \end{array}$$

the specific gravity of the compound particle.

Thus the compound particle has $\frac{4}{1}$ times actual surface exposed to the force of the water and only 6.875 effective gravity to resist it. Or, as the specific gravity of the compound particle is to the specific gravity of the gold particle, or core (ratio of gravities), so is the area of the compound particle ÷ area of the core (ratio of applied force) to the relative force applied.

6.875 : 20 :: $\frac{4}{1}$: 11.63 relative force applied. Or, ratio of gravity : ratio of applied force :: unit of gravity : relative of force applied.

Thus: the relative force applied (of water) would be 11.63 times greater upon the compound particle than upon the simple core; and $\sqrt{11.63} = 3.4$ times the relative velocity of water.

(It resolves itself into the proposition, that the resultant relative resistance such a particle thus filmed would offer to the force of the water, would be .086 of that of the simple particle.)

Conversely, if falling vertically through still water, the gold particle alone would fall with 3.4 times greater velocity than the compound particle.

If a particle of gold be filmed one tenth its diameter, as above, it will be subjected, in moving water, to a relative force of 2.10 times that of the clean particle alone, encounter a relative velocity of water of 1.45, and present a resistance of .475, with a specific gravity of 13.68.

If the film be 1. the force would be 2.42, the velocity of water 1.55, the resistance 4.13, and specific gravity 11.91.

It is manifest that the resistance offered to moving water (or the velocity with which they would fall through still water) by solid bodies of equal sizes, but of unequal specific gravities, is as the ratio of their specific gravities.

Assume the specific gravity of the gold particle to be 20.; the compound particles above. respectively, 6.875, 11.91, and 13.68; black sand 5. and common sand 2.5; then the relative forces, velocity of water, and resistance, would be:

	Specific gravity.	Applied relative force.	Relative velocity of water.	Relative resistance.
Gold	20.000	1.00	1.00	1.000
Compound No. 1	13.680	1.46	1.20	.685
Compound No. 2	11.910	1.68	1.30	.595
Compound No. 3	6.875	2.90	1.70	.345
Black Sand	5.000	4.00	2.00	.250
Common Sand	2.500	8.00	2.80	.125

The following table is constructed for comparison with the above, from the same elements, The final processes, or "undercurrents," so called, are constructed upon a wrong principle to prevent the escape of certain particles, possessing certain peculiarities, and tend rather to facilitate their escape than to retard it.

The gold caught upon the undercurrents of the North Bloomfield Gravel mining company was about three per cent. of the whole yield. There was no indication that all the gold was exhausted from the debris. The undercurrents were continued to such an extent that a further continuation would have been unprofitable. And still the fact remains, that the debris in the cañon will yield, with careful panning, an average of two grains of gold per cubic yard. None of this gold can come from the black sand, for the sand will not surrender its attached gold by being immersed in water for any length of time. (See NOTE H.)

The Milton Company, at French Corral, saved about fifteen per cent. of their total gold crop upon undercurrents. At the Manzanita mine there was saved about ten per cent. In neither of the above instances was there any important saving of the black sand, or the heavier portions of the debris.

Every hydraulic miner knows that amalgamation ensues much more readily in warm than in cold weather. It is known that quicksilver becomes more potent in its amalgamating tendencies as its temperature increases. It can be proved by experiment that in water at thirty-three degrees, particles of gold of certain peculiarities, will utterly refuse amalgamation with pure quicksilver. If the water be brought to a higher temperature amalgamation readily follows. The inference is, that where the flume water is near the freezing point, considerable gold may pass away free, even though it may have come into contact with the quicksilver in the flume.

There has been but little, if any, improvement on the application of the principles involved in hydraulic mining, since the time when a bull's horn was the first nozzle and a split puncheon the first riffle.

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showing the relations between the simple gold cores and the compound particles, as well as the black and common sands. Velocity of water=1:

	Specific gravity	Ratio of thickness of film to diameter of core	Specific gravity of film	Specific gravity of compound particle	Ratio of area of surface of film to area of core	Ratio of volume of envelope, or film, to volume of core	Relative force applied.	Relative velocity of water	Relative resistance
Gold core	20								
Compound particle 1		$\frac{1}{10}$	5	13.680	$\frac{1.44}{1}$	$\frac{1.728}{1}$	2.10	1.45	.475
Compound particle 2		$\frac{1}{10}$	1	11.910	$\frac{1.44}{1}$	$\frac{1.728}{1}$	2.42	1.55	.413
Compound particle 3		$\frac{1}{2}$	5	6.875	$\frac{4}{1}$	$\frac{8}{1}$	11.63	3.40	.086
				Simple.					
Black sand		0	0	5.00	0	0	4.00	2.00	.250
Common sand		0	0	2.50	0	0	8.00	2.80	.125

NOTE H.—It is probable that the particles of gold arrested by the undercurrents are of a peculiar form and of a less density than those deposited in the flumes, which enables them to rest upon the surface of the table in shallow water, where in deeper and in more rapidly moving water, and surrounded by a dense mass of moving sand, they would be washed away; or, rather, where the water is so shallow, there is but little velocity for one or two lines above the surface of the table.

The changes have been nearly confined to the increased magnitude of the operations. There have been no changes whatever in the processes for the separation of gold from the earthy matter. The processes are the same now, in all their details, as they were thirty years ago; the same system of flumes, the same system of blasting and breaking up obdurate material, the same hurrying of the freshly broken earth into the flumes, the same system of separating bars, or "grizzlies," and undercurrents, the same disregard of the peculiarities, characteristics, and requirements of the gold particles, and the same waste of so large a proportion of the precious contents of the gold bearing earths.

Managers seem to be unwilling to admit that there has been always more gold lost than has passed into dividends; and yet it is beyond doubt, although it cannot be proved, that there is more gold in the cañon, that has escaped from the flumes, than has been realized in profits from hydraulic mining. The apparent total loss is so appalling that one hesitates to announce an estimate of the possibilities, saying nothing of the probabilities.

The use of two thousand inches of water per day (say two thousand two hundred cubic feet per miners' inch) would amount to six hundred thousand inches per year. One inch of water will work, on an average on a large scale, more than four cubic yards of earth, making, say two million four hundred thousand cubic yards of earth in one year; of this earth, more than one fiftieth of one per cent. is black sand; this would amount to four hundred and eighty cubic yards of black sand. This will yield more than one thousand dollars per ton; it will weigh more than three tons per cubic yard. Thus, $480 \times 3 \times \$1,000 = \$1,440,000$ as a loss from black sand alone.

More than one half of one per cent. of the total quantity of earth washed consists of the hybrid sulphurets before referred to, of which none is systematically saved. This would amount to twelve thousand cubic yards, or sixty thousand tons per year. It will yield more than twenty dollars per ton, amounting to one million two hundred thousand dollars per year.

To the above add the millions of fugitive gold particles, impalpable, that are known to exist in the gravel, and which cannot possibly subside in rapid water. (See NOTE I.)

Add the so-called "rusty gold" (known to all hydraulic miners), referred to in the report of the State Mineralogist of California for 1880. [The writer has seen many ounces of it.] Add the gold that is contained in matrices that become disintegrated only after a long exposure to air and water, and which is known to exist because it is found in the debris in the lower cañons, free and clean, and which could not possibly have come from any other source.

The possible losses sustained in the last three paragraphs can only be admitted, they cannot be estimated. But the gold is known to exist in the forms therein mentioned, and it is known not to be saved.

Improvements have been and are constantly being made in all branches of mining save this particular one. With the inception of

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NOTE I.—There are intangible or impalpable particles of gold, so minute and presenting so great a surface in proportion to their weight, that they are very tardy in obeying the laws of gravitation in so dense a medium as water even though the latter should be motionless. They may be of maximum density and of regular form, and still have almost a disability of displacing the atoms of water with which they may be surrounded, and subsidence takes place very slowly.

the process, progress seems to have stopped. It is true that water is more easily controlled and directed than it was thirty years ago; more powerful explosives are used; works of greater magnitude have been constructed, and mountains are now moved where molehills were then. But, so far as the more perfect separation of the gold from the earth is concerned, absolutely no progress or improvement has been made. And no other mining process is so extravagantly wasteful, and in no other kind of mining is so little heed paid to the requirements of natural laws. The reason may be found in the fact that hydraulic mining, as now practised, is comparatively a new art.

It was only such a condition of circumstances that existed, and events that occurred in California immediately preceding and succeeding the Mexican War, that rendered possible hydraulic mining upon a large scale.

Given a virgin country of vast extent, recently acquired by conquest, without laws or precedents, almost without population; abundant water at high elevations and rich gold deposits midway between the sources of the water and tide level; an influx of an immense number of intelligent, energetic, industrious, hardy men, of all nationalities; of men who were capable of making and maintaining their own local laws; with no traditional riparian rights of others to observe or respect; no rules governing the appropriation, diversion from their natural channels and utilization of rivers of water, save those made by the newcomers themselves, and, of course, suited to their own purposes; a popularly elected judiciary that adopted these crude mining rules and made them the fundamental laws of the territory and State—that of absolute ownership of appropriated and utilized water, with right of way for ditches, and possessory title to the discoverers and locators of mining ground; constructively conveying the right to fill up and obstruct the navigable rivers and tidal bays with the debris from the mines.

The necessities of hydraulic mining require such a latitude of action, and such a departure from the laws and traditions of old civilized communities. Should gold gravel deposits be found along the Croton River, New York, they would not be permitted to be worked extensively by the hydraulic process, for the following reasons: No water could, at the will of the mine owner, be appropriated and diverted for the purpose. And again, because the debris from the mines would infringe upon the vested rights of the down-stream land owners, and would tend to obstruct the navigation of the Hudson River, and to destroy New York Bay as a harbor.

The requirements of hydraulic mining render necessary the construction in the mountains of immense reservoirs. The water from them is conducted by canals to the mines, fifty or more miles away, with sufficient elevation to carry it to any desired point. When the gold-bearing gravel banks have been exhausted, in a hundred years, more or less, these reservoirs and canals will yield their stores to irrigate the thirsty hillsides and plains below them. Without the mining inducements, the reservoirs would never have been built. Thus, when the men who made them are dead and forgotten, and the gold that was the inducement and the reward for their being built will have been scattered broadcast over the world, they will continue for all time to pour their riches into the lap of the agriculturist, and make of arid wastes luxuriant fields.

HYDRAULIC AND DRIFT MINING.

By HENRY DEGROOT, M. D.

HYDRAULIC AND DRIFT MINING.

HYDRAULIC MINING.

Briefly described, hydraulic mining may be said to consist in the plan of breaking down and disintegrating the auriferous gravel as it stands in place, and carrying it into the gold saving apparatus prepared for receiving and washing it, by means of water discharged through iron pipes upon such gravel under great pressure. In drift mining the gravel is reached and removed through shafts, inclines, or tunnels, and afterwards shoveled or piped into sluices and there washed in the same manner as that operated upon by the hydraulic process.

The business of searching after and securing gold by the drift method of mining, though not peculiar to California, nor yet wholly of modern origin, has, in this State, reached such proportions, and been prosecuted by means and appliances so varied, novel, and effective, that it may almost be said to have originated here.

As regards the hydraulic branch of the business, what constitutes its most noticeable features, the employment of water under pressure, the breaking up of the indurated gravel with gunpowder or other explosives, and effecting its further disintegration by dropping it over precipitous falls—in short, all that is most characteristic about it is so new, so wholly without precedent, that it may be considered exclusively the product of California. Limited and imperfect at the start, this industry has developed into one of overshadowing magnitude; more than one fourth of the annual gold yield of this State, approximating now twenty million dollars, being extracted by the hydraulic process. Of the balance four millions may be credited to the drift mines, seven millions to the quartz mines, and the remainder to various forms and methods of placer mining other than hydraulic and drift.

Expanding, little by little, this hydraulic system has seemed more a growth than an invention, every year since its inception having witnessed such additions and changes as have sufficed to keep it constantly spreading and advancing. These gains, though sometimes small and seemingly unimportant, have been universal and continuous, consisting now in slight innovations upon previous methods, and again in modifications of old or the introduction of new devices, or perhaps in improvements worked in the application of those already in use.

NEW DEPOSITS AND NEW MODES OF WORKING THEM.

The discovery of gold in California, an event that happened a little more than thirty-four years ago, drew to this part of the Pacific

Coast a numerous, eager, and energetic population. As the most of these newly arrived immigrants repaired at once to the mines and there engaged in the business of gold gathering, the more shallow and accessible placers were worked out with such rapidity that but for the timely discovery of more permanent deposits, and the employment of improved ways and means for working them, placer mining here would have undergone speedy curtailment and perhaps suffered early extinction. These later discoveries consisted of the auriferous gravel found in the inhumed beds of the pliocene rivers, and the vast accumulations of like material lying over and adjacent to these ancient channels; the improved instrumentalities above alluded to having been none other than those devised and introduced in the progress of hydraulic and drift mining. Included in these discoveries there were, then, two classes of deposits, the difference between which lies more in the methods and agencies employed for extracting and utilizing them than in their genesis, modes of occurrence, or the material of which they are composed.

THE DEAD RIVERS.

While drift mining is confined almost wholly to the beds of these ancient but long since obliterated streams, the superincumbent and outlying gravel banks constitute the principal sites of hydraulic operations. This latter class of deposits is very extensive, covering large areas to depths varying from a few yards to several hundred feet. They may, in fact, be said to be nearly co-extensive with the California gold fields, the deepest, most fruitful, and strongly marked being met with in the central and northern portions thereof.

The finding of these pliocene deposits was, like the original discovery of gold, unexpected and gradual, having been the result of chance rather than of any preconceived theory or systematic plan of exploration. In the prosecution of their labors, the pioneer miners were early led to observe that the gulches and cañons entering the rivers immediately above the exceptionally rich bars, were themselves apt to contain great quantities of gold dust. Following up and washing the gravel along such gulches and cañons, these miners encountered on either side thereof what appeared to be fertile streaks or "leads," to the breaking down and disintegration of which these depressions were evidently indebted for their special enrichment. These "leads," on being traced up, were found to run under the banks of the cañons, the courses of which, before their destruction, they had crossed at various angles. The further explorations of these strange formations not only showed them to be the receptacles of great wealth, but disclosed the additional fact that they occupied deep, rocky, water-worn channels, once the beds of broad and swift-flowing streams. To these latter, so extinguished and entombed during the long ages of the past, the miners of the period gave the striking and appropriate name, "Dead Rivers," a term by which they have continued to be designated ever since.

EXTENT OF THE OLD RIVER SYSTEM AND ITS CONTEMPORANEOUS GRAVEL DEPOSITS.

These gravel deposits, as before remarked, cover, in one shape or another, a considerable portion of the California gold fields. Only, however, in the more central mining counties, being those reaching from Tuolumne to Plumas, inclusive, are the "dead rivers," proper, and their associate gravel banks met with. In Trinity, Humboldt, Siskiyou, and Del Norte counties, occupying the northwesterly angle of the State, extensive beds and deep-lying channels of gold-bearing detritus abound; but they lack the peculiar features that, if present, would warrant their being referred to the pliocene age. The most of them are clearly of recent origin, having been formed by the shiftings of the present streams and other agencies of comparatively modern date. Many of the hydraulic banks in this group of counties are due to landslides, which, coming down from the adjacent mountains and filling up the rivers, have diverted them from their former channels, in the great bends of which these masses now stand, peninsular in form, and with sides distinctly terraced. These terraces, or benches, two and sometimes three in number, denote the different planes on which these rivers formerly ran. Having been kept on a certain level for a long time, the stream formed along its banks broad alluvial flats, or bottoms. Through earthquake or other disturbance in the earth's crust, opening a new channel for the river, or breaking away the barrier that had so long maintained it at this particular level, the bed of the stream was lowered for a considerable distance, leaving another of these high benches with its flat surface and sloping sides, as we now find them, the entire series, through a repetition of this process, having in course of time been produced.

Coursing across these benches, at depths varying from thirty to one hundred feet, are found distinct and well defined river channels, their descent corresponding with that of the present stream. While these channels are invariably rich, and are apt to have the gold pretty evenly distributed along them, there occur here none of those remarkable finds that distinguish the workings of the "dead rivers" proper, being those that pertain to the post-tertiary or the early-quartenary eras.

It has been suggested, and some plausible arguments have been adduced in support of the hypothesis, that the deeper of these deposits are of submarine origin, at least in part. The mass of them are, however, very clearly made up of fluviatile and diluvial drift, as are also those found in Oregon, as well, most likely, as in every other locality where hydraulic and drift mining have been practiced, outside of the central group of counties mentioned.

Some miners have a theory that there are remnants of the pliocene wash still standing in Trinity, Siskiyou, and adjacent counties, the great body of it having been broken down and afterward carried away and redeposited on lower levels, forming the benches and bars seen at present along the rivers in that section of country. This theory receives so little support from recognized facts that it may be said to rest almost wholly on hypothetical data. While these northern gravels would so seem to be of comparatively modern origin, it is still the case that the most attractive openings for the inauguration of new hydraulic enterprises are to be found in that part of the State.

In certain sections of California, generally classed as non-mineral, the remains of what appear to be channels or washes, analogous to those above described, have been discovered and traced for some distance. One of these, near Calpella, Mendocino County, has been, according to report, followed and identified for a distance of twenty-five miles. This channel is well defined, wide and deep, as is shown by the exposed banks on either side of Russian River, which has swept a considerable section of it away. It appears to be filled from top to bottom with river-washed gravel composed mainly of serpentine and quartzite rock, there being but little pure quartz in it. But for the lack of sufficient fall in the vicinity to carry off the tailings, and the heavy expense that would attend bringing water upon it, portions of this gravel could probably be worked with profit by the hydraulic method, as it unquestionably carries some gold, and, save in the matter of insufficient outlet, is favorably situated for cheap and rapid handling.

Very considerable deposits of auriferous gravel occur also in Los Angeles and San Bernardino counties. Like those above described, they are of secondary origin, but, as working trials conducted at several points tend to show, are of rather low grade. A number of years since, certain of these deposits were, at considerable cost, equipped and operated after the hydraulic plan, but failing to prove remunerative or even reimburse the outlay attendant on bringing in water, equipping, and opening them up, they were subsequently abandoned, nor have any attempts since been made at working them. In like manner, the efforts made at hydraulic gravel washing along the southerly end of the central tier of mining counties, have, as a general thing, brought but poor returns; the conditions in these counties being, for the most part, unfavorable, though the deposits themselves are apt to be tolerably good. But here, as in all these outlying localities, we note a general absence of the regular old river channels, and the high grade gold-bearing gravels, their inseparable concomitants. South of Mariposa County, we detect neither the "dead rivers" themselves nor the billowy accumulations of auriferous detritus that mark the sites of their sepulture; the Red Bank mine, on the Merced River, being as far, in that direction, as any considerable quantity of really good gravel has yet been found or any hydraulic operation prosecuted with much success.

WHEN AND HOW THE DEAD RIVERS PERISHED.

Touching the age of these old time rivers, their sources and directions, the nature of their contents, the manner of their filling up and subsequent burial under lofty ridges and basaltic mesas, and, finally, their partial disinterment through the degradation of their inclosing mountain masses, geologists are pretty well agreed—that is, in so far as the main facts are concerned; volcanic outpourings and earthquake disturbances; diluvial drift; glacial, tidal, and fluviatile action; ocean surfs and currents; uplifts of the earth's surface, clogging them with detritus through diminished grade; climatic changes, causing increased water flow; chemical decomposition; frost, heat, wind, and other meteorological agents, being by scientists universally recognized as among the more potent factors concerned in producing these phenomena.

That mutations so complicated and vast could not have been wrought within the limited period that has elapsed since the birth of our globe, as taught by the old theory of creation, must, of course, be conceded. But geological facts establish for the earth a much greater antiquity than that assigned it by this now exploded system of cosmogony. Science, turning over the leaves of the great "stony book" of nature, discovers for our world a long life and an eventful history—a history marked by commotion, revolution, and change; these movements having been sometimes sudden and violent, upheaving mountains, disrupting the earth's crust, and destroying wide ranges of animal life; and sometimes slow and tranquil, sparing the most tender organisms, and little disturbing the then existing order of things.

Hardly yet has the popular thought awakened to the consciousness that geological time is not to be measured by years or ages, but by such almost illimitable periods, that they seem, to our feeble comprehensions, eternities of duration. Very inadequate, too, are our conceptions of the changes and transpositions that in times past have taken place on the exterior of our globe, which, as we see it now, has been, in good part, reconstructed from the ruins of preëxisting systems. Tall ranges of mountains were once the floors of the sea, and the inhabited continents of to-day were, long ago, submerged beneath the ocean, and there kept, till the sedimentary deposits accumulating, raised their surfaces above the water; or they were lifted up bodily by the slowly operating forces that had before carried them down.

It was in the midst of convulsions and cataclysms like these, when a long night of storm deluged the westerly continent; when volcanoes lighted the crest and glaciers rooted out the sides of the Sierra; when the great basin of the Sacramento was rapidly filling in, and the foothills were being raised from the sea, that these deep-lying gravel banks were formed, and this system of "dead rivers" was blotted out and buried up.

Among the causes directly implicated in the production of these changes, floods, and volcanoes; the disrupting, comminuting, and transporting power of icebergs and glaciers; local uplifts and subsidence of the earth's surface; ocean surfs and tides, and the erosive effect of running water, were the most widely prevailing and potent; many of these agencies having succeeded each other in regular order, and remained active throughout long periods of time. When we reflect that the ocean tides, at a time when the moon was much nearer the earth than at present, ran from six to eight hundred feet high, we find here a wearing and displacing force that must have eroded the rocks, against which it impinged, at a rapid rate and kept the loose material exposed to its fury in a state of fearful commotion. A single influx of such a tide would suffice to heap up great drifts of gravel, which the ebb might add to, or possibly carry away, scattering it far and wide, to be still further dissipated, or perhaps again heaped up by the next incoming tide.

It was during the early tertiary, if not before, that the channels of these ancient rivers were mapped out and eroded. That their grades were then steep may be inferred from the enormous size of many of the bowlders found distributed along them, to say nothing of the much larger number that were probably carried further down and swept into the great depression now occupied by the Sacramento, San Joaquin, and Tulare plains, then a long extended sea-trough more than a thousand feet deep. These bowlders composed of hard rock, show, by their rounded forms and polished surfaces, that they must have been moved by rapid currents and traveled a long distance, a thing that would have been impossible had these pliocene rivers then run on their present low grades; or supposing these immense masses of solid rock to have been worn into their present shapes previous to their being carried into these river channels; still the latter must have been much steeper than they are now to have imparted enough force to the water to move such weighty masses for such long distances.

HOW THIS REDUCTION OF GRADE WAS EFFECTED.

After these old rivers had been so running for ages and ages over their swift descending beds, the country west of the Sierra Nevada, including its foothills, then covered by the great inland sea that reached west to the Coast Range, was slowly elevated, undergoing a total uplift of eight or nine hundred feet, reducing to that extent the fall in these rivers and diminishing in like ratio the velocity of their currents. As a result their channels were eventually filled up to the top of the rim rock on either side, and often to a much greater height with the bowlders, gravel, sand silt, and shingle, that before had been carried down and poured into the great receptacle that afforded for all these antediluvian streams an ample "dumping" ground.

A like choking up of these rivers would have ensued from a greatly lessened waterflow, but, in the absence of proof that this occurred as a contemporaneous event, we are bound to accept the theory here adduced as furnishing the true solution of this filling-in process, the evidences of its soundness being varied and conclusive. Along the western flank of the Sierra Nevada, at about the altitude mentioned, marine shells and fossils of various kinds are met with, attesting the presence of the sea there at some former period. The same thing occurs along the sides of the hills that environ the valleys of the Coast Range, as well, also, as at many points on the peninsula of San Francisco. Amos Bowman, who, while a member of the State Geological Corps, under Prof. Whitney, paid much attention to this subject, holds to the theory here advanced, supporting the same by many pertinent facts gathered over a wide field of observation. According to the same authority, the sides of the mountains and hills throughout this region abound with wave-worn beaches, shore lines, plateaus, flats, and terraces, denoting, at the points where they occur, the presence of former ocean levels. The gravel that fills up these valleys is also of subaqueous origin, the remains of marine plants and animals being found intermixed with it to a depth of several hundred feet. At the time these deposits were going on, Mount Diablo and Tamalpais were islands, and St. Helena a peninsular point of land standing in what Mr. Bowman terms the Pliocene Gulf of Alta California. The exposure of these shore lines, shells, and other submarine creations, must have been due to an elevation of the land and not to a subsidence of the ocean, which, inasmuch as the volume of water it contains is fixed and invariable, must always remain at the same general level. In effecting changes of this kind the sea is the steadfast, the land the unstable element. These oscillations of the earth's surface, though not well understood as to their causes, are, and ever have been, going on in some parts of the world, submerging the shores of one country and raising those of another above the sea. These movements are so slow, however, that the effects produced by them are little noticed by the people of a single generation or century.

Gradually, as the fall in these old rivers was diminished, the material brought down by the water grew finer and finer, the moving power being insufficient to force along the great bowlders, or even the coarser shingle that readily found their way down over steeper grades. As a general rule, the bowlders diminish in size, and the gravel becomes smaller and smaller, while the proportion of sand and silt increases as we approach the surface of these deposits.

OF WHAT THIS MATERIAL IS COMPOSED.

The bulk of this auriferous detritus, as we find it resting in the old river channels, or massed in the deep hydraulic banks, is made up, for the most part, of silicious sand, fine and coarse gravel, clay, formed from volcanic ashes or other sedimentary deposits, lava, tufa, conglomerates, fossilized wood, and bowlders. The latter, as already remarked, occur, usually, near the bottom, and are often of great size, single stones weighing as much as fifteen or twenty tons being frequently met with. This detritus, in the form of secondary deposits, is found, also, gathered on the modern river bars and alluvial flats and basins, or spread out over the low prairies and rolling foothills, where both hydraulic and drift mining are sometimes prosecuted with good results, though not generally on a large scale. The rocky portion of this material is composed mostly of quartz, accompanied with fragments of every rock common to the Sierra Nevada, such as slate, serpentine, granite, etc., all more or less rounded and water-worn. There is also intermixed with it a small percentage of magnetic iron ore, in the shape of black sand. Fossils, both animal and vegetable, and at some points in great quantity, occur in the middle and upper strata of gravel. These organic remains consist of the bones and teeth of various animals, the trunks and branches of trees partially or wholly silicified, lignites and carbonized wood, in all of which latter the vegetable structure is clearly apparent. Cords of petrified wood have, in some places, been uncovered; also, Indian mortars and similar rude implements, proving the existence of man prior to the filling in of these pliocene rivers.

Sometimes the contents of these old river channels and hydraulic banks are composed of gravel from bottom to top; oftener, however, they consist of layers of gravel, sand, volcanic ash or clay, and lava, occurring usually from the bottom up, in the order here mentioned. Again we find this material interstratified without much regard to regularity, the lava, where any is present, constituting always the upper and the gravel the lower stratum. These bodies of sand, like the layers of volcanic ash, are sometimes flat but oftener lenticular in shape; both vary much in size, being from a few feet to six or eight and occasionally as much as ten or twelve yards in thickness, their linear being always many times greater than their vertical extent. This sand, also a volcanic product, is sometimes so loose and dry that, if left unsupported, it crumbles under its own weight. Where it lies near the bottom or rim-rock, this arenaceous substance, being saturated with water, becomes a quicksand, causing much trouble when encountered in the excavating of shafts, inclines, or tunnels. Sometimes it is found hardened into a semi, and occasionally into a very compact sandstone, great masses of it in this condition resting under some of the table mountains. The volcanic ash occurs, superimposing the layers of sand or interstratifying the gravel, with which, however, it is never mixed up. Moistened with enough water to form it into a paste, it would appear to have flowed down the old river channels, until hardening, it was left in the places where we now find it. Some writers on the subject consider it merely a sediment deposited at high water, not different in its composition and origin from the mud left by ordinary inundations. To this material the miners have given the name "pipe-clay," a substance which it much resembles, being of a grayish white or brownish color, fine grained, and cutting like chalk. The microscope shows it to be composed of mica, feldspar, and quartz, with some feldspathic scoria in the upper strata.

Where not denuded, as large portions of them have been, the contents of these pliocene channels are covered with diluvial drift and volcanic flows, either in the shape of scoria, sand, and mud, or basaltic cappings, which latter take, usually, the form of mesas or table mountains, a structure that will be more fully noticed further on. These lava flows, which reach, sometimes, a thickness of more than a hundred feet, prove fatal to hydraulic washing wherever they occur in much volume, their hardness and thickness interposing an insuperable obstacle to their removal. The detritus accumulated outside the old river beds, composed in part of volcanic and in part of true auriferous gravel, is apt to be free from lava coverings though often found deeply buried under masses of volcanic ash, and so impacted by chemical agents and pressure as to be almost as difficult of removal as the lava itself. It may be here observed that the term "lava" is, in popular usage, applied to much material that is not strictly such. For example, the heavy strata of volcanic sand and ash that occur in many parts of the mines, pass, locally, under the name of "white lava," while to another variety of this material, colored darkly by ferruginous stains, the name "black lava" has been given. Though their constituent parts are mostly of volcanic origin, these substances never have been in a molten state, but having been partially liquified by water, were afterwards brought down and distributed by the same agency. While some of these pliocene channels, notably that of Tuolumne County, running nearly coincident with the Stanislaus River, were obviously filled up by a single flow of molten matter; this, in other cases, was accomplished only through successive and long continued eruptions. So, also, the accumulations of auriferous detritus would, in certain instances, appear to have resulted from one overwhelming movement while in others they were effected by diverse and oft exerted agencies operating through a long series of years.

THE BLUE LEAD.

In the "dead rivers" proper, of California, the bottom stratum of gravel, besides being greatly impacted, is generally stained a deep blue color. Observing this peculiarity, and, further, that the gold here found seemed to be confined to a narrow streak, the discoverers of this class of deposits, named the first one met with "The Blue Lead," the word "lead,"—a corruption of the term "lode,"—having been applied by them to this stratum of gravel by reason of its supposed resemblance to an ore-bearing lode or vein. The definite article "the," was prefixed as above, because this blue stratum, when discovered, was thought to be the only formation of the kind in existence. Save in the matter of color, however, the name has proven to be a singularly unapt one, inasmuch as these formations, instead of being confined to a single one, have since proved to be very numerous in this State, the misnomer being still further emphasized by the fact that these deposits are not marked by any feature characteristic of a lode or vein whatever. In this latter sense, the deposit is virtually a nonentity, while every "dead river" in California may be said to have its "Blue Lead," that is, its bottom stratum of hard blue gravel, a color imparted to it by the underlying slate, and fixed by the chemical action of the ferric oxide escaping from the sulphurets of iron, always abundant in these bottom strata of gravel. On being exposed to the oxydising effects of the air, or to atmospheric water, this stuff loses its characteristic hue, taking on a reddish brown, or purple tint, or a blending of all these with perhaps some other colors. It then, also, undergoes rapid disintegration, or "slacks," as the miners term it, a process that converts it, when wet, into a soft mud, and when dry, into a sandy powder.

BIRTH OF THE PLIOCENE RIVERS—ORIGIN OF GOLD.

Eons ago, the westerly shore line of the continent lay east of the Sierra Nevada Mountains, the country to the west of that range, including nearly the whole of California and a small strip of Nevada, being then covered by the Pacific Ocean. While so submerged, the mud that afterwards formed the auriferous slates of the lower Sierra and its foothills, accumulated upon the ocean's bottom to a great depth. In process of time, the region now occupied by the Sierra Nevada and its westerly lying foothills, began to emerge from the sea, but coming up so slowly that, for many years, it remained comparatively low and flat. During this period the pliocene rivers were born. Having their sources in the far interior, they meandered slowly through the great champaign, forming islands, side channels, bayous, deltas, and lagoons on their long journey to the ocean. Then it was that the fluviatile system, that at this day so puzzles the scientists and savants to decipher, was platted out, and the "dead rivers" entered upon the work of eroding their channels.

Traversing a region so broad and flat, these streams, pursuing their devious courses, doubled on themselves and ran for long stretches in every direction. The water-shed tributary to them was extensive, covering a portion of the Great Utah Basin, and most of the country now drained by our California rivers, and, perhaps also, the southerly confluents of the Columbia. Gradually, as these countries continued to be forced up, the river grades became steeper and steeper, thereby accelerating their currents and augmenting their erosive powers. This increased swiftness, while it deepened, tended also to straighten the channels of these rivers, causing them to forsake portions of their former beds, and seek their points of debouchment by more direct routes. This, with these ancient streams, was not only the wearing but also the transporting era, when along their deepened channels immense quantities of detritus and alluvions were swept and emptied into the estuaries or directly into the adjacent seas.

After the Sierra Nevada Mountains had been raised to a height much above their present summits, carrying up with them the superimposed slates and schists, this upward movement was arrested, and the work of their degradation began. Under the erosive effects of the atmosphere, water, frosts, and other elements, aided, to some extent, by earthquakes, icebergs, and glaciers, this work proceeded rapidly, inundating the country below to a depth of several thousand feet with the ruins of these mountains and their slaty covering. So vast was the quantity of this debris that the "dead rivers," which now occupy sites far above the beds of the present streams, coursing, in some instances, along the crests of lofty ridges, ran at that day in valleys several and perhaps many hundred feet deep.

But all this material was barren, no gold had as yet been eructed from its primary sources in the deep bowels of the earth. There was no need for it. No animal had yet been created having any use for a metal so pure and refined. The inhabitants of our globe throughout all the ages, down to and far into the Cenozoic, got along well enough without it. The ichthyosaurus and the megatherium, the saurians that wallowed in the fens and the aquatic monsters that disported themselves in the ancient seas, were of a non-commercial, non-hoarding habit. But a notable event was about to happen in the progress of terrestrial things. Man was soon to appear on the scene, and nature, anticipating the necessities and desires of this new animal, made provision for bringing up a portion of this auriferous stuff from the molten interior and placing it within his easy reach. To this end she managed, a little before his advent—geologically speaking—to inject into the slates and schists, already tilted up, numerous gold-bearing quartz veins, which, besides working a considerable change in these rocks, impregnated them more or less with the royal metal. The erosion of these slates, schists, and quartz veins, after they had been so impregnated with gold, having released this metal, it was carried down intermixed with the detrial mass, and distributed along the old river channels and in the other localities where we now find it.

This effected, commenced the uplift before spoken of, and which, by diminishing the grade of these rivers, caused them to fill up with bowlders, sand, and gravel,

THE VOLCANIC FLOWS

Coming in a little later and completing the destruction so begun. The line of this eruptive activity traversed the summit of the Sierra Nevada, along and near which innumerable burning peaks belched forth great quantities of ashes, sand, cinders, and lava toward the close of the tertiary period. The evidences of these volcanic outbursts are met with along this mountain range for a distance of nearly five hundred miles. From Shasta on the north, to Tehachipi on the south, patches of lava, tabular and conical, capping the granite or resting in granitic basins, masses of basalt, dark and columnar, crater remains, beds of ashes, breccia, and cinders everywhere abound. Having been energetic throughout a geological "day," these perturbations grew fainter and fainter, and at last subsided altogether. The earthquakes disturbed no more. The molten rivers, like their pliocene predecessors, ceased to flow, and the volcanoes were extinguished. Then came

THE ICE PERIOD,

And the climate, from a torrid was changed to an arctic temperature. The tropical died out, and a boreal flora came in. Glaciers accumulated on the tops of the Sierra, rooting out those lacustrine basins, and furrowing its sides with deep cañons, into which the waters of the "dead rivers," long seeking escape through numerous small channels, were finally gathered, and commenced cutting the gutters of the present westward flowing streams—and the gelid season being long continued, accomplished a great work. The glaciers and the icebergs born of them, crushing the surface rocks into fragments, comminuted portions of them into sand, or ground them into mud, the water and the frost acting both chemically and mechanically, coming in to aid these disintegrating and triturating forces. The copious rains falling through an atmosphere heavily charged with carbonic acid absorbed that gas, and carrying it to the earth, tended much to promote the decomposition of every kind of rock, except only the purely silicious.

And so the masses of detritus before created were, during this stormy and frigid epoch, largely increased. Through the force of gravity and of running water the finer and lighter portions of this eroded material were brought down and distributed over the country below, being left there in the various forms in which the placer miners now attack it. The piles of drift that compose the ridges, or "divides," standing between the modern rivers that cut the westerly slopes of the Sierra, were derived from this source. To this period, too, must be referred all the placers lying above the levels of the ancient rivers, and in part, also, the shallow diggings of the lower foothills. The larger fragments of the disrupted rocks, and such other heavy material as these moving agents were unable to bring down, remained behind strewn over the lofty basins, heaped in moraines, or massed along the mountain sides where the dying glaciers had left them.

But at length "the morning and the evening" of this "day" also came to a close. The cold of the long dark Winter began to abate, the isothermal lines creeping slowly towards the south. The sun's rays, struggling through the thick mists and the deadly vapors, gave birth to a higher plant growth and new types of animal life. The ice fields, diminishing, finally disappeared, and the rushing streams, fed by them so long, waned and dried up. "The monsters of the great deep" retired to their element, the more gigantic and misshapen having suffered extinction. Birds and mammalia of more perfect form were created, and our earth, progressing through the centuries that make tertiary time, was fitted for the abode of man, who thereupon made his appearance, the physical features of California having, meantime, taken on something of the aspect for which they are now distinguished.

THE COURSES PURSUED BY THE "DEAD RIVERS."

Touching this question no great diversity of opinion exists, those who have given it most attention agreeing that the ancient river system conformed, in its general outlines, to that of the present day. Mr. C. J. Brown, long a resident of Placer County, after carefully studying the problem on the ground, formed the opinion that this system consisted of a westerly flowing main trunk, having two large and far extended arms coming in, the one from the north and the other from the south, their point of confluence being near the center of Nevada County. From this point the main trunk, after running due west a distance of some twenty-five or thirty miles, debouched into the Pacific ocean, which then extended as far east as the lower foot-hills of the Sierra Nevada. These two arms, the beds of which were but little elevated above sea level, had numerous tributaries which drained the low hill country then lying to the east, the Sierra Nevada mountains having not as yet been lifted up.

Viewed as a whole, this old river system, with its short main trunk, its long branches and their many ramifications, presented much the appearance of a wide spread oak. The two outstretching arms, except in coincidence of locality, corresponded to the Sacramento and the San Joaquin of our day, running in nearly the same directions, and having, like them, through numerous confluents, drained an extensive water-shed lying to the east. While the foregoing theory may, in some minor particulars, be open to correction, as a whole it receives support from many well substantiated facts, some of which have been ascertained since its first promulgation. Mr. Brown, it is proper to state in remarking upon this subject, recognizes the existence of several of these "dead river" systems, subordinate to the one above obtained.

As delineated on the map prepared by him for illustrating the courses of these subterranean channels and their branches, the latter almost all come in from the northeast or the southeast, whereas the rivers that now traverse that section of country flow, for the most part, nearly west-southwest. In locating these branches as above, the compiler of this map fell into an error, inasmuch as their courses were less regular, conforming at the same time more nearly to those of the modern streams than by him represented. The most of these departed rivers were, in fact, exceedingly crooked; so much so that their numerous and violent sinuosities, by creating the appearance of parallel channels in close proximity to each other, have led some observers into the mistake of unduly multiplying their number. At several points along them this feature becomes strikingly apparent. How devious must have been the course of the main south trunk along that portion of its route reaching from Gold Run to Quaker Hill is disclosed by the fact that it ran, or is supposed to have run, through all the leading mining camps between these two places. As its passage through these several localities would render the course of this great south artery a perfect plication, there is warrant perhaps for assuming that there occurred at this point a network of these ancient channels, a number of them having come in from various directions and centered here; this being more reasonable than to suppose that the main trunk pursued a course so exceedingly tortuous. Elsewhere this stream, as laid down on the map referred to, would appear to have followed a course equally capricious, running within a linear stretch of a few miles towards almost every point of the compass.

MINING CAMPS AND LOCALITIES ALONG THE "DEAD RIVERS."

Tracing the courses of these ancient rivers, as above presented, we find that the main trunk, beginning at its point of debouchment, in

Yuba County, and pursuing it east, runs through the following towns and mining localities, viz: Timbuctoo, Smartsville, Sucker Flat, Rough and Ready, and Grass Valley, to its junction with its two principal confluents at Scott's Flat. Its northern arm, as we follow it up, passes through or near Blue Tent, North Bloomfield, Orleans Flat, Minnesota, Alleghany, Forest City, Rock Creek, Fir Gap, Deadwood, Poker Flat, and thence on north into Plumas County, where further traces of it are lost in the neighborhood of Nelson Creek. From the vicinity of Forest City, a branch appears to strike off from this channel in a northeasterly direction, fructifying the diggings around and beyond Downieville. From the main trunk, a subordinate channel seems also to set out at a point a few miles above Smartsville, and running, first in a northeasterly and then in a northerly course, passes through French Corral, San Juan North, Camptonville, and Brandy City, to Poverty Point, where it forks, one branch passing up easterly and the other along the westerly side of Slate Creek Basin. The former, after leaving Poverty Point, passes through Scales' Diggings, Port Wine, Monte Cristo, Cedar Grove, Saint Louis, Chandlerville, and Howland's Flat, to Hepsidam, a few miles beyond which it disappears under Pilot Peak, a tall volcanic cone, the uplifting of which has effaced every vestige of both. This and its twin channel, which, coming up through the tier of mining camps on the west side of the basin, suffer obliteration in like manner on their approach to Pilot Peak. This west-lying channel, after leaving Poverty Point, passes through Spanish Flat, La Porte, Gibsonville, Mount Pleasant, and Whisky Diggings, besides several other mining localities of lesser importance.

Returning now to Scott's Flat and following the southerly branch of this great hydrographic tree, it leads us, under the same guidance, south through Quaker Hill, Red Dog, You Bet, Little York, Dutch Flat, Gold Run, Iowa Hill, Yankee Jim's, Todd's Valley, Georgetown, and Coloma, where it deflects to the southeast and strikes across by Placerville and Newtown, about as far as it has yet been distinctly traced in that direction, if indeed any "dead river" proper has, on the line here indicated, ever been traced beyond Todd's Valley. Be that as it may, certain it is Mr. Brown, in recognizing but four subordinate channels on the Forest Hill divide, and in carrying these directly to the northwest by nearly straight and parallel routes, has been greatly at fault in his attempted reconstruction of the "dead river" system, this above all other localities being distinguished alike for the great number of its large, rich, and strongly marked pliocene channels, and the extremely tortuous courses they pursue. Nowhere have the intricacies and eccentricities of the ancient river beds and the unfoldment of their mysteries more puzzled the expert than here, the old channels on this "divide" forming many sharp angles, and running often not only side by side, but sometimes two or three tiers deep. Reaching a great territorial expansion they come in from every quarter, commingling, doubling upon and even crossing each other on different levels.

It should be stated that many mining localities situate along these old river channels on the Forest Hill divide have not in the foregoing enumeration been mentioned, some of those omitted being places of much importance. No mention, for example, has been made of Wisconsin Hill, Bath, Michigan Bluff, Last Chance, or Damascus, all located between the north and the middle forks of the American River, and greatly enriched by the various buried "leads" known to exist on that "divide."

So, too, a number of similar mining centers situate on the high ridges that separate the several forks of the Yuba and Feather rivers, as well as many other camps lying farther to the north and west, have, in like manner, been overlooked, these places being all located on the channels already spoken of, or on some of their branches, which latter, the smaller ones included, are very numerous. This system of "dead rivers," taken as a whole, covers a scope of country something like one hundred and fifty miles long and thirty or forty miles wide.

THE LOST RIVERS AND ICE CAVERNS OF IDAHO.

While the pliocene rivers of California, by reason of their strange formation, the wealth they contain and the mystery that enshrouds the time and manner of their destruction, are so calculated to excite our curiosity and interest, and even impress us with a sort of awe, we find in the so called "Lost Rivers" of Idaho phenomena almost equally well calculated to awaken inquiry and inspire us with wonder. In the southern portion of that Territory, large creeks, and sometimes streams of such considerable size as to be denominated rivers, suddenly disappear, being precipitated into dark rocky chasms and never more seen. These fissures are old lava channels, produced by the outside of the molten mass cooling and forming a tube, which, on the fiery stream becoming exhausted, has been left empty. The roof of this lava duct, having at some point fallen in, presents there the opening into which the doomed river plunges headlong and is lost. At one place along the banks of the Snake, one of the "Lost Rivers" re-appears gushing from a cleft high up in the basaltic walls. whence it leaps a cataract into the raging torrent below. Where this stream has its origin, or at what point it has been swallowed up, is, however, all a mystery, further than that its sources are known to be somewhere in the country to the north.

Besides becoming the channels of living streams, these lava conduits are sometimes found filled with masses of ice, which never wholly melt. When serving this end, so unlike their original purpose, they are called ice caves or caverns.

Reference is made here to these "lost rivers" and basaltic remains, for the reason that they have an origin analogous to that of the "dead rivers" of pliocene times, the lava flows and like agencies having been largely concerned in the production of both; they also disclose how nature in her capricious moods has indulged in these eccentricities in comparatively modern as well as in the more remote ages of the past.

Dr. Raymond, in the fifth volume of "Mining Statistics of the Regions West of the Rocky Mountains," describes these "Lost Rivers and Ice Caverns of Idaho" in his usual intelligent and felicitous manner.

In connection with the pliocene rivers of California there occurs a number of those equally strange and unique formations known as

TABLE MOUNTAINS,

Under which we find buried the best examples of a fully perfected and well preserved "dead river" extant. These "table mountains," the *mesas* of the Spaniards, which so stand over and mark the sites of the fossilized rivers, are, like these rivers themselves, a species of geological remains peculiar to California. These remarkable elevations are composed, for the most part, of lava-flows which, issuing from the volcanos along the crest of the Sierra and running down the already partially filled channels of the ancient rivers, covered their contents with a molten mass, which, on cooling, left them capped with a heavy stratum of basaltic rock. These remains are not now numerous or extensive; the table mountains that once stood over many of the pliocene channels having suffered destruction and disappeared altogether, or left only faint traces of their ruins behind. What were once tall and far-reaching structures, exist now only as isolated sections or low rocky mounds; their relics gathered in long, half buried ridges, or scattered widely over the adjacent plains. Even the best preserved of these lava-built *mesas* extend now for only a few miles unbroken. Where not wholly demolished, they have been at many points intersected and large portions of them carried away by the modern rivers, leaving them so disjointed and fragmentary that, looking across the deep chasms that divide what is left of them, it is hard to believe these far separated mountain wrecks formed once a complete and continuous plateau.

But though disrupted and so nearly destroyed, these fragments remain the silent witnesses of the fiery floods and physical commotions that marked the close of the pliocene epoch, the enduring monuments of the mysterious past, the fit mausoleums of the "dead rivers." Lifting their fortress-like forms far above the surrounding country, they must forever stand a geological sphinx, exciting alike the wonder of the thoughtful scientist and the careless observer.

Viewed from a distance, these "table mountains" have the appearance of long wall-shaped ridges, bald and so nearly level on top that their inclinations are imperceptible to the eye. A talus of the broken rock fallen from above has almost everywhere formed along their bases, reaching up two thirds of the way or more to the top, their sides above this talus being perpendicular and often impending. Their upper surfaces, almost wholly bare and timberless, are strewn, sometimes quite thickly, with large, black, and scraggy bowlders, slightly rounded, and mostly of uniform size and shape. These bowlders are of volcanic origin; are, in fact, nothing but loose and disjointed masses of basalt, indicating by their rough exteriors that they have "weathered" into their present shapes where they lie. The supposition that they could ever have been subjected to the action of running water, or even to much attrition upon each other, is precluded by the position in which we find them. Being nearly destitute of soil, little is ever found growing on the tops of these mesas, except perhaps a few shrubs or stunted pines.

The most extensive and notable of these plateau remains are those known as the Stanislaus and the Concow, or Cherokee, Table Mountains; the former situate along the Stanislaus River, mostly in Tuolumne but partly in Calaveras County, and the latter at Cherokee, in Butte County, and both of which, protected by the unusual thickness and the excessive hardness of their basaltic coverings, have escaped to a remarkable extent the disintegrating and eroding effects of the elements that have so devastated these structures elsewhere in the State.

The following description of the Stanislaus *mesa*, much the more shapely and well preserved of the two, will serve to convey some idea of this class of formations generally. Commencing in the southerly part of Calaveras County, this lava flow, after following for several miles in a west southwesterly course along or near the stream whose name it bears, crosses the same into Tuolumne County. After entering this county it runs, holding nearly the same course as before, for a distance of eight or nine miles, when it is again intersected and a mile or more of it carried away by the Stanislaus River. Re-appearing on the opposite bank of this stream, it pursues its course five miles southwest, where its continuity suffers another interruption, a mile and a half of it having been here broken down and swept off by the waters of Black Creek. Beyong this chasm it comes in again, precipitous and strong, holding, without further break to its final terminus seven miles below; the entire *mesa*, gaps included, being about thirty-five miles long. On the southeasterly side of the Stanislaus, opposite the reach that terminates at Black Creek, stands a heavy body of table land, evidently a part of the original mass, which, here spreading out into what might have been a sort of lacustrine expansion, has been intersected by the river, leaving a portion of it standing on either side.

On top, this table mountain varies from sixteen to eighteen hundred feet in width, its summit being nearly two thousand feet above the Stanislaus River, and five hundred feet above the common level of the country adjacent, the general surface of which has, since these table mountains were formed, been lowered to the extent of three thousand feet, or more. Through this process of degradation the entire topography of the country has been reversed. The "dead rivers," now inurned high above the beds of the living streams, ran, during pliocene times, in deep depressions, while the bottoms of the valleys of that period are now on the tops of lofty ridges, some of them being nearly two thousand feet above the present rivers.

In general terms, these mesa piles may be said to be composed of the following material, viz: A top stratum of basalt, from fifty to one hundred and forty feet thick, very hard, dark colored, and in places, distinctly columnar; underlying this, is forty or fifty feet of pipe clay and sand. Next comes in a layer of coarse gravel, usually from ten to twenty feet in thickness, and under this the pay streak, which consists, usually, of some four to six feet of finer gravel lying on the bedrock. These strata, while they vary in thickness with different localities, usually occur in the above order; the pipe clay and sand, a sedimentary deposit, stratified in beds, sometimes horizontal but oftener lenticular, run frequently into a fine sandstone, which crumbles readily on being exposed to the air. The absence of any perceptible partings in the volcanic capping of the Stanislaus deposit would denote that, thick as it is, it had all been poured out at a single flow. The pliocene river buried under this basaltic mass, having been partially disentombed by the pick of the miner, has shown itself to be, everywhere, more or less auriferous, as has been the case, also, with such other of these ancient channels as have in like manner been reached and explored. Where covered by table mountains, these channels have to be opened up and their contents removed by the drift method of mining; only, as at Cherokee Flat and Morris Ravine, where the superimposed basalt has been broken down and removed, can they be worked by the hydraulic process.

Having thus briefly described the origin, extent, and general character of the deposits to be handled by the hydraulic and drift methods of mining, we come now to consider the ways and means employed for utilizing the same; and first of

HYDRAULIC MINING—EARLY HISTORY AND PROGRESS OF THE BUSINESS.

Where, in California, hydraulic mining originated, or who was its inventor, if invention it can be called, is, at this day, a matter of uncertainty, two parties and two places laying claim to this distinction. One of these parties, whose name is unknown, is said to have employed water under pressure for washing gravel on a ravine claim at Yankee Jim's, Placer County, as early as the Spring of 1852. The apparatus here used was crude and of limited capacity. The water, taken from a small ditch running along the hillside near by, was carried in a flume and emptied into a barrel, set on a frame about forty feet high, whence, escaping, it was conducted through a rawhide hose six inches in diameter and discharged upon the gravel to be washed. To this hose was fitted a four-foot tin tube, ending in an inch nozzle. Supposing this statement to be well founded, we have in the above feeble effort and sorry appointments, the origin of hydraulic mining as at present conducted in California. In the application of water to gravel washing through such crude contrivance, we detect the life germ, or, as the Darwinian philosopher might phrase it, the protoplastic idea of the business.

About the same time, a miner named Chabot, working some ground at Buckeye Hill, near Nevada City, contrived a plan for bringing water upon the same through a sort of penstock, being a set of inclined wooden boxes, so strengthened by iron clamps that they were enabled to withstand a pressure of fifty or sixty feet. To the lower end of these boxes was attached a four-inch canvas hose, through which the water was conveyed to and discharged upon the gravel to be washed. Although there was no nozzle affixed to this hose, the water under the above head, and so compressed, escaped from it with such force as to greatly facilitate washing operations.

In the month of April, 1853, E. E. Matteson, member of a small company mining in the same vicinity, rigged a hose much after the style of that already in use at Yankee Jim's, but, as it is asserted, without any knowledge that a similar machine had before been invented, if, indeed, such were really the case. As it is possible that both of these parties and places may justly lay claim to the paternity of this process, as above set forth, we shall, in the absence of authoritative data on that point, assume that it was really so.

Perceiving the benefits likely to arise out of this novel application of water in gravel washing, the miners failed not to avail themselves of it wherever the conditions would admit of their doing so. The alacrity with which these men hastened to adopt the new method was, in fact, such as seemed to argue on their part not only a ready perception of its present advantages, but also an early consciousness of its vast possibilities. Received so favorably at the outset, operations by the hydraulic process, or "hydraulicking," as it was called, were speedily extended throughout all the more central mining counties. So rapid indeed was the growth of the business, that it came in the course of a few years to be overdone to such an extent that a reaction, followed by a long season of depression, ensued. This reaction did not, however, result from over-confidence in the new mode of procedure, but from other and extrinsic causes. The miners, not then aware that the gravel below a certain, and in most cases a very inconsiderable depth, would become so hard as to require powder to shatter and large quantities of water to disintegrate and run it off, commenced operations on areas so small. that the stock of material available with their imperfect outfit and limited supply of water was soon disposed of. This point reached, they were forced to suspend operations, their claims being too small to warrant the expenditure necessary for putting them in proper shape and bringing on the requisite amount of water, even if the owners had possessed the means for making these improvements, which generally they did not.

And so after a considerable impetus had been given to hydraulic mining in a small way, this industry, after it had been tolerably prosperous for five or six years, suffered a relapse, and this, notwithstanding many valuable improvements had meantime been introduced. Throughout the decade that followed 1857, this, in common with most other branches of mining in California, was much neglected, owing to the heavy tide of emigation that had in the interim set towards British Columbia, Washoe, Idaho, and other, for the time being, more attractive countries. During this period hydraulic mining, but for the efforts of a few large companies, would have remained in a comparatively rudimentary state, production restricted and active operations so depressed as to amount to an actual retrogression of the business. After an experience so discouraging, small companies and individual claim holders being willing, as a general thing, to dispose of their interests on easier terms and at more moderate figures, these properties were largely bought up by parties of more ample means, who then aggregated them into estates of sufficient size to justify their being thoroughly opened up, well equipped and abundantly supplied with water. With this change a new and better era came in for the business. Small enterprises gave place to larger ones. Companies who confined their labors to running off the loose top gravel diminished, while those capable of successfully handling the hard bottom strata, increased in numbers. Money in larger sums began to be invested, improvements of every kind assuming, at the same time, grander proportions. Ditches and reservoirs of increased capacity were constructed, other portions of the mining plant having been, in like manner, enlarged and perfected. The green rawhide hose, subject to early decay and ever liable to burst, was soon displaced by stout cotton canvas, a material not only more lasting, but capable of sustaining a greater pressure; this canvas, in turn, giving way to iron pipes, still stronger and more enduring. The tin tube disappeared and cast iron cylinders, with detached nozzles, came into use. The miniature gold saving apparatus first employed was superseded by long, well riffled sluices, supplemented by undercurrents, secondaries, and similar adjuncts. Instead of being confined to thirty or forty feet, as at first, water came to be used under a pressure of two or three hundred feet. Bedrock tunnels were projected and commenced for drainage and working purposes, cement mills were put up for crushing the hardened gravel, and an infinitude of auxiliaries, great and small, were pressed into the service of the hydraulic miner.

But with all this improvement and progress this industry was not without its difficulties and drawbacks. With the season of its decadence over, the obstacles incident to the business did not cease. On the contrary, they seemed to increase as operations were extended, old troubles becoming aggravated and new ones presenting themselves. Large improvements called for large expenditures, and novel agencies presented novel obstructions; forces powerful enough to overcome one set of impediments failing not to beget new ones. The washing down of immense quantities of gravel tended to diminish the grade and fill up the outletting channels. If a much greater amount of water was to be brought in, ditches skirting precipitous cliffs and spanning deep gorges had to be extended far into the mountains, where frost and snow, land-slides, avalanches and other hindrances, before unheard of, had to be encountered. Any increment in the volume of water used in washing, through its increased tendency to carry off the finer particles of metal, necessitated the making of corresponding additions to the gold-saving appliances. The opening up of the gravel beds in depth, compelled the employment of gunpowder and other explosives for breaking up the indurated material, and also of expensive and powerful derricks for handling the bowlders; and so of other costly requirements, which, keeping even pace with the general advancement of this industry, have rendered it one of extreme difficulty and not always free from pecuniary hazard. Nor have these untoward conditions been confined to the medieval age of the business. They attend it still; they form an integral and inseparable part of it. As they vexed his predecessor, so have they in turn continued to vex the hydraulic miner of the present day, who seems likely to transmit the exigencies of the situation, little abated, possibly intensified, to his successors in interest.

TERMS AND PHRASES EMPLOYED IN CONNECTION WITH HYDRAULIC MINING—THE USE AND MEASUREMENT OF WATER, ETC.

Preliminary to what is to be said concerning the ditches, reservoirs, and other structures used for collecting, storing, and transmitting water, it may be well to define certain terms and phrases which will be found of frequent occurrence in the description about to be given of this class of improvements and the varying standards of measurement adopted in buying and selling water, some of these terms being original with the California miners, while nearly all have a peculiar or local signification.

By the term "grade," as used in mining affairs, is meant the amount of fall given to a ditch, flume, sluice, etc., or that occurs in running water. The sluice grade is determined by two different methods of measurement, the one being the fall that occurs in a linear distance of twelve feet—the length of an ordinary sluice box—and the other by the percentage of fall; the latter being the most intelligible, and the method now most in use.

"Tailings" consist of the gravel that has been once washed and thereby deprived of all the coarse and most of the fine gold it originally contained; this waste stuff being also called debris, detritus, slums, and sometimes by the absurd name of *slickens*.

"Dump" signifies the amount of fall had at, or immediately below, the outlet to the mine, and which, according to its extent, affords greater or less facilities for dropping the tailings down, or running them off out of the way; insufficient "dump" proving, sometimes, a fatal trouble with otherwise good mines.

A "run" denotes the length of time gravel washing is continued without stopping to "clean up"—that is, collect the gold caught in the sluices, undercurrents, and other apparatus provided for the purpose. In length the "run" varies with circumstances, extending through one, two, or three months, and, occasionally, throughout the entire season.

The term, "a miner's inch of water," is of California origin, having grown out of the method of measurement here adopted by the ditch companies in disposing of water to their customers.

"A miner's inch of water" varies with different localities to such an extent that it may almost be said to constitute an arbitrary quantity. This arose from the practice that obtained in the early days, whereby each ditch company having water to sell fixed the quantity to be represented according to such standard as best suited themselves, and which, coming to be generally recognized, grew at last into a custom having the force of law in that locality. Hence the disparity in this respect that prevails throughout the mining districts of the State. In the delivery of water, the varying elements consist of the head, or pressure, and the size of the aperture. The "miners' inch" that has come to be most widely accepted is the quantity of water that will flow from an orifice one inch square through a two-inch plank, with still water standing to a depth of six inches above the top of the orifice. Through a plank so perforated two thousand two hundred and seventy-four cubic feet of water will escape in twenty-four hours—nearly seventeen thousand gallons. Where this method of measurement is adopted, a long horizontal slit, one inch high, is made in the discharge box, a slide being used to regulate the number of inches which it is intended shall escape. This being a simple and convenient arrangement for determining the quantity of water delivered, accounts, in part, for its popularity. At Smartsville, an opening two hundred and fifty inches long and four inches wide is used for measuring the water, which escapes under a pressure of seven inches above the top of the opening, the discharge so effected being one thousand "Smartsville" inches. The flow here is equal to one and seventy-six hundredths cubic feet per minute—two thousand five hundred and thirty-four and forty hundredths cubic feet in twenty-four hours. The South Yuba Canal Company discharge water through a two-inch aperture in a one and a half inch plank, and under a pressure of six inches measured from the center of the aperture, while the North Bloomfield, the Milton, and the La Grange companies calculate the inch by a flow through an opening in a three inch plank, fifty inches long and two inches wide, the water standing seven inches above the center of the opening. The Eureka Lake and Canal Company adopt an orifice two inches high, under a pressure of six inches; if this orifice be ten inches long, twenty inches of water escape. In some cases the water is delivered under a pressure of not more than three or four inches, and occasionally without any pressure at all.

A series of experiments was made not long since by A. J. Bowie, Jr., to determine the effective value of the "miner's inch," under the following conditions: Water discharged through a rectangular aperture fifty inches long and two inches wide, in a two-inch plank, and under a pressure of seven inches above center of the opening. Result:

One miner's inch discharged in 1 second	.2499 cubic feet.
One miner's inch discharged in 1 minute	1.4994 cubic feet.
One miner's inch discharged in 1 hour	89.9640 cubic feet.
One miner's inch discharged in 24 hours	2,159.1460 cubic feet.

In these experiments, the ratio of effective to theoretical discharge was found to be only 59.05 per cent., being somewhat less than shown by similar experiments conducted by Hamilton Smith, Jr., a short time before.

Efforts have been made from time to time in the State Legislature to have the quantity of water contained in a "miner's inch" fixed by law, one or more bills having been introduced in that body with a view to effecting this object. One of these bills provided that such inch should consist of the amount of water that will pass through an orifice one inch square through a plank one inch in thickness, and under a pressure of seven inches, measured from the center of the orifice. For one reason or another these bills failed of enactment, chiefly because it was thought best to leave the quantity of water, like the price, to be regulated by the miners and ditch companies themselves, as neither of these parties had shown any great desire for a change. Nevertheless, there are good reasons why this quantity of water should be fixed by statute, thus rendering it uniform and certain, whereas there are none whatever why it should be suffered to remain vague and indeterminate, causing often much hardship to the consumer of water, and also sometimes serious inconvenience where the term requires to be legally defined. In mechanics, "an inch of water" has a settled and definite meaning, and so also should it be in mining usages.

By the term "head of water," is meant the quantity sold by the ditch owner to any one mining company, or the quantity used by the latter from whatever source obtained. In hydraulic operations, "a head," varies from two or three hundred up to as many thousand inches of water. Few companies buy as much as four thousand inches, though some there are, who, owning it themselves, consume even a greater quantity, running it through their own ditches. Hardly any companies run a "full head" the year round, the most of them abating the quantity largely as the dry season advancing diminishes the supply.

In selling the water, the inch, or "head," is reckoned for the length of time the water is used, which may be for twenty-four hours, or for ten, twelve, or such other number as may be agreed upon. The price of water for a ten hour run varies from six or eight to twenty cents per inch, thirty to sixty per cent. additional being charged for twenty-four hours. Some little abatement is generally made in favor of large and steady consumers. To those who take but little water, and at irregular periods, as in the case of drift miners, the above rates are apt to be advanced. There are probably as many as a million and a half ten-hour inches of water sold throughout the State in the course of a year.

DITCH LOCATION AND CONSTRUCTION.

As water has been the principal agent engaged in releasing the gold from its original matrix, and transporting it to the *placers* or places where we now find it, so has this element in the hands of man been forced to undo a portion of its work and help separate the precious metal from the worthless material with which it had before so helped to mix it up. Being so indispensable, then, for the successful prosecution of this branch of mining, the first thing to be done, where a hydraulic enterprise is contemplated, is to make provision for an ample supply of water, it being presumed that the auriferous character of the gravel to be worked has been proven and the sufficiency of the outlet or dump established beforehand. If a company have already introduced water into the neighborhood, and have it for sale, this supply may be obtained from them. If not, then a ditch of suitable dimensions must be constructed for taking water from the most available source at command and conveying it to points where required for use. To obtain, in the central mining counties of California, anything like a large and really serviceable water supply, unless it be purchased of parties holding under a previously established franchise, is not, at this day, an easy matter. All the water within easy reach has, in fact, been appropriated to an extent that leaves no surplus after the supplying streams have met existing requirements upon them, unless it be during the three or four months that such streams are kept replenished by the winter rains or the melting of the snow on the mountains, the former occurring at a period of the year least favorable for hydraulic operations. By reason of the extent to which the water has so been appropriated, hydraulic mining in this section of the State may be said to have very nearly reached its limit of greatest practicable expansion. Only through the construction of additional reservoirs for its storage can the stock of water be here much augmented. Under these circumstances, any large increase in the quantity of tailings likely to be hereafter discharged from the mines through an extension of hydraulic operations, need not be apprehended. In the north-westerly group of mining counties there is still much summer water running to waste. This water, though generally claimed, has not been diverted from its original channels, and can be secured at little cost. These counties afford, therefore, a better field for ditch building than now offers in the centrally situated counties further south.

Aqueducts, of one kind and another, have, from the first, constituted an important auxiliary to the mining industries of California, commencing to build them on a small scale having been almost coeval with the gold epoch itself. As early as 1850, small ditches were dug for bringing on a "tom" head of water, their size having been increased soon after, when the sluice came into use. Though short and of limited capacity at the start, these improvements have so increased in magnitude and number, as well as in the engineering skill displayed in their construction, that some of them, with their supplying reservoirs, fairly rival many works renowned for their boldness of design and national in their objects and character. The most of the earlier enterprises essayed in this line proved financially fortunate, the ditches dug being short and comparatively inexpensive, while water met with ready sale at high prices. This encouraged to the undertaking of too many works of the kind, entailing loss where profit was expected. The much tilted slates that strike broadly across the mining regions, being unfavorable for the retention of water, there occur, within that belt, few streams capable of filling a large sized ditch. To secure more full and permanent supplies the water had to be taken from the main rivers, which necessitated the building of much longer ditches than were required when it was obtained from local sources. Many of these longer and more extensive ditches were built at a time when both labor and water rates remained at high figures, though both, through the rapid exhaustion of the surface placers, had greatly depreciated before these works were completed, whence it happened, that the latter, though built at great cost, yielded only diminished revenues when they came into use.

All through the period that hydraulic mining remained especially depressed, being the second or middle stage of the business, ditch properties made such poor returns that the owners sometimes allowed them to be sold to satisfy judgment creditors, or abandoned them altogether, some very costly works having suffered the latter fate. What worked much disaster to these early ditch owners was the mistakes into which, through inexperience, they often fell, either in locating or building their canals; the erection of lofty and expensive flumes, to be soon blown, burned, or rotted down, well illustrating this latter class of blunders. For these costly and short-lived structures earth excavations or iron pipes are now generally substituted.

In the preparation of the following remarks on ditch, dam, and flume construction, the able and authoritative article on these several topics prepared by Charles Waldeyer, and published in the reports of the Commissioner of Mining Statistics, has been freely drawn upon. Some use has also been made of the essay on Hydraulic Mining, by Aug. J. Bowie, Jr., a paper replete with useful information on the subject treated of, and which has met with general commendation on the part of hydrostatic engineers and practical miners.

In locating the route of a projected ditch and selecting the source of its water supply, both should be maintained at as high a level below the deep snow line as possible; another point to be held in view being the securing of an ample Summer stock of water, including facilities for its storage. If kept at a high elevation the ditch will command a larger scope of mining territory, besides being able to deliver the water under increased pressure, a condition on which its effective power is largely dependent. The ditch, if too low, loses these advantages; if too high, it is liable to suffer obstruction from snow and ice, delaying the season of active operations, and necessitating considerable expense for freeing it from these impediments. With a given amount of water, more and better work can be done in warm than in cold weather. Among secondary objects to be kept in view, during the preliminary stages of these enterprises, is the securing, by location or purchase, of all streams along the main trunk that can be readily made tributary thereto. By attending to this, any waste occurring through evaporation, absorption, or leakage, may be made good, and the water flow thus be kept to the full carrying capacity of the ditch; which latter, where such addition to the water is feasible, may, sometimes to great advantage, be enlarged along its lower portions, where the difficulties of construction are apt to be less than they are higher up. These subsidiary streams may also be serviceable in helping to replenish the main ditch when its principal sources of supply begin to fail, as they usually do with the advance of the dry season. Where it is not desirable to empty the water of these side streams into the main ditch, it is to be carried over or under the latter, as found most convenient. Because of the rapidity with which evaporation goes on in the warm and arid climate of California, deep and narrow ditches, other conditions being equal, are preferable to broad and shallow ones. Where, however, the former involve the necessity of much extra bedrock cutting, economic considerations require that they should give place to shallow ditches made wider.

FLUMES, TUNNELS, GRADES, ETC.

In the construction of these artificial aqueducts it almost always becomes necessary to transmit the water, for a portion of the way, through tunnels, iron pipes or flumes, recourse to the latter being had where a deep ravine or other depression is encountered, affording no facilities for carrying a ditch around the head of such depression, or where to do so would unduly increase its length; and, again, where the water has to be conveyed, at a considerable elevation, through a gorge having steep rocky sides, with too little earth to hold a ditch. In the former case, recourse to fluming is much less frequent now than aforetime, depressed iron pipes having been largely substituted for these wooden structures, which, besides their great cost, have proved to be exceedingly ephemeral and insecure. Their average life has not exceeded eight or ten years in consequence of their liability to destruction by wind, fire, and early decay, those put up at greater altitudes being, moreover, exposed to be swept away by avalanches, or crushed under the weight of the snow.

In the early history of ditch building, some of the flumes erected were very lofty, reaching often a height of one hundred and fifty, and, occasionally, as much as two hundred feet or more; one put up at Big Oak Flat, in Tuolumne County, having attained the extreme height of two hundred and fifty-six feet. Though very simple structures, not involving any great amount of mechanical skill, some bold feats of engineering were displayed in the building of these flumes. This was especially the case where they required, as sometimes happened, to be fastened high up against the sides of precipitous cliffs, the workmen performing their labors on scaffolds suspended from above.

Of this method of hanging flumes from the sides of steep cañons, there is presented, on the line of the Miocene Company's ditch, Butte County, a notable example. This ditch, which traverses, for the most part, an exceedingly rugged country, reaches on its route a locality where the Superintendent of Construction, Wm. H. Bellows, had left him only the choice of erecting a trestlework nearly two hundred feet high, for supporting the flume, or adopting the plan of resting it on brackets attached to the side of a vertical cliff three hundred and fifty feet high. Having made choice of the latter alternative, workmen were slung in ropes over the edge of the precipice and dropped down, more than two hundred feet, to the level of the projected flume, where they drilled two lines of holes into the basaltic wall, the one for the reception of the brackets and the other of their supporting braces or suspenders. The brackets here used are made of T rails, bent into suitable shape, ten feet projecting horizontally from the face of the wall, for the flume to rest on, and two feet at the ends, rounded off for the purpose, entering and being firmly fastened in the lower line of holes made for their reception. The other end of the bracket, which terminates in an eye, is bent at right angles, and passing upward, outside the flume, holds it in place. Into this eye the lower end of the supporting brace, made of heavy round iron, is fastened, the other end entering one of the holes in the upper line, into which it is secured by clamps and soldering. The brackets are eight feet apart, each one being capable of sustaining fourteen and a half tons' weight. The flume, which is four feet wide and three feet deep, has capacity to carry three thousand miners' inches of water. Before reaching this bracketed section it is supported on a long string of trestlework, eighty feet high. Elsewhere on the line of this ditch are two similar structures, one, one hundred and thirty-six feet high, and the other, one thousand and eighty-eight feet long and eighty feet high. The bracketed portion of the flume is four hundred and eighty-six feet long and one hundred and eighteen feet above the foot of the cliff.

The box or body of the flume is usually made of one and one half inch boards, good lumber, sugar pine, where it can readily be procured, being used for the purpose. The supporting frame work may be and generally is made of coarser stuff, such as ordinary pine, spruce, fir, and the like, its size and strength being proportioned to the duty required of it. The sills or sleepers on which the sustaining posts are set should be charred, as a protective against decay, and all high flumes ought to be anchored with strong wire or wire rope to hold them firmly against the wind. The building of flumes, wherever practicable, should be dispensed with, both on account of their original cost and the current expense of keeping them in repair. While this style of conduit costs in the first instance from forty to sixty per cent. more than a ditch, the outlay upon it, so long as it lasts, is in about the same proportion, the annual expenditure on this account amounting to at least ten per cent. of the original cost. The ditch, when finished, is all the while growing better, and, if properly located and well built at first, requires thereafter but little renewal, and never entire reconstruction, being, in this respect, the reverse of a flume.

As sheet iron flumes would manifestly possess many advantages over those built of wood, it may reasonably be expected, now that the price of this material has been so much reduced, that it will yet come to be largely employed for such purpose. Iron, protected by coal tar or other substance against oxidation, besides being more durable, would, on account of its smoother surface, offer less obstruction to the passage of water than sawed lumber.

The fall given to the California mining ditches ranges from six to twenty-five feet per mile. These are the extremes, the average being about thirteen feet—three eighths of an inch to the rod—which experience has shown to be about the proper grade, as this insures a tolerably large delivering capacity without imparting to the current a velocity calculated to rapidly wash the banks. The tendency of late years has been toward the adoption of steeper grades, the firm earth of the mountains resisting erosion, while the deep narrow ditches are more easily kept clear of snow and ice than wide ones.

Even after their completion, more or less trouble is for a time experienced with all ditches, through land slides, breakage, sipage, etc. In the course of a year or two, however, if well built, their banks become so solidified and their sides and bottoms so covered with sediment that they lose little by leakage and are easily kept in repair, unless they be of extra large size, or the ground is unusually loose and porous.

While it is proper in the construction of aqueducts of this kind to commence work simultaneously along the entire line, it often becomes expedient to finish the upper part first, to the end that, the water being let in, it can be used to float down the lumber required at points below. Usually the best timber is found along the upper portions of the ditch and much is gained by cutting it there and floating it down in the manner mentioned, instead of transporting it by teams, which becomes expensive, especially if the hauling has to be done over rough ground and ascending grades.

In running the lines of a ditch, projecting points and ridges are sometimes encountered which require to be pierced with tunnels as a means of shortening the route or securing a passage on a proper level. Generally these adits are short, though in a few instances they reach a length of a thousand and even two thousand feet or more.

THE DAMS, WASTE GATES, AND SNOW GUARDS

Pertaining to these aqueducts and essential to their protection and efficiency need not here be described with much particularity, their forms and uses being generally well understood. The dams connected with these mining ditches do not differ from similar structures elsewere, save in that they require to be built especially strong to secure them against the extreme high water that annually occurs in the mountain streams of California. Owing to the great abundance of fine timber found near their sites, they are built, for the most part, of lumber, advantange being taken of the low stage of water that always prevails toward the end of the dry season to put them in. The waste gates, placed at proper intervals along the ditch, allow the water, after reaching a certain level, to escape, thereby protecting the banks from undue pressure, as well as preventing the water raising so high as to overflow and wash them away. The "snow-guard" so-called, consists of a low shed or covering, composed of strong timbers placed over the ditch where it runs along the side of a steep declivity, for the purpose of protecting it against the snow, which, at these points, crowding down steadily or sliding in suddenly from above, is apt to cover the ditch up to a great depth, or carry it away altogether. Even the iron pipes laid down for conducting the water along these places, have sometimes to be in like manner shielded, or they would be crushed flat by the weight of the snow.

DEPRESSED IRON PIPES.

This style of conduit is employed to convey water, not only over shallow depressions, superseding, when so used, the elevated flumes, but also for transmitting it across ravines and gorges too wide and deep to be spanned by a flume, and around the heads of which a ditch cannot well be carried. Of such use of iron pipes, in connection with ditch enterprises, we have several noted examples in California, the most extensive and costly work of the kind in this State being that of the Spring Valley Canal and Mining Company, at

Cherokee, Butte County. The pipe here laid down carries the water of the company's ditch across the West Branch, a tributary of the North Fork of Feather River, and has capacity to discharge fifty-two cubic feet of water per second. It is fourteen thousand feet long, has an approximate interior diameter of thirty inches, and, at its lowest point, is subjected to a pressure of eight hundred and eighty-seven feet. The heaviest material used in its construction is three eighths inch boiler iron, English plate. Though in use for nearly eight years, this pipe is still in good condition, showing, in fact, little visible impairment by time. At a point further up, the water of the same ditch is conducted across Little Butte creek in a similar pipe, depressed one hundred and forty-eight feet, and nearly one thousand feet long. At several other places in the State these inverted siphons have been put down, and always with satisfactory results. In some instances, where these deep gorges are to be crossed, the iron pipes have been suspended from wire cables instead of being laid on the sides and bottoms of the cañons; but this, where the pipe is of very large dimensions, would hardly be practicable.

NUMBER, LENGTH, AND SIZE OF MINING DITCHES IN CALIFORNIA.

All told, the number of mining ditches in this State amounts to several hundred. Many of them, however, are small, carrying only from fifty to two or three hundred inches of water. Those on which the hydraulic diggings are mainly dependent, are capable of carrying all the way from four or five hundred up to four thousand, and even as much as six or seven thousand miner's inches of water. The main trunk of the South Yuba Canal, extending from the head dam on the South Fork of Yuba River, down to Bear River, a distance of one and one half miles, transmits, for that distance, the unusually large quantity of seven thousand inches of water. This part of the company's canal is six feet wide on top, five feet deep, and has a fall of thirteen feet to the mile, giving it the largest carrying capacity of any ditch in the State. The Chalk Bluff branch of this ditch, when full, conveys over four thousand inches. During the greater part of the year, this company runs to the various mines supplied by their system of ditches over two hundred million gallons of water daily.

The aggregate length of all the mining ditches in the State will reach very nearly, or quite, six thousand miles, besides something like one thousand miles of subsidiary branches, not to mention the many small distribltors required for taking the water from the larger ditches or reservoirs, and carrying it to the various points on the mining claims where it is needed for use. As regards length, these ditches vary greatly, some of them being not over three or four miles long, while others reach a length of forty or fifty, and, in a few cases, even as much as seventy or eighty miles. As a general rule, the longest ditches are found in the more central mining counties, extending from Mariposa to Plumas.

COST OF DITCH BUILDING.

The cost of these structures varies, of course, with their size, length, and the natural obstacles and other hindrances encountered in building them. It is the case, however, that large ditches cost more, proportionally, than small ones, the money expended upon the former ranging from four or five up to fifteen, and occasionally as much as twenty thousand dollars per mile—cost of dams, flumes, and iron pipes, where the latter have been used, being included in the estimate. In some parts of the State medium-sized ditches have been built for two thousand dollars per mile, and even less. This disparity in the cost of these works is due to the difficulties to be overcome in constructing them, and which, in some cases, are very formidable. To such obstacles as are apparent and can be counted upon in advance, there is to be superadded that element of uncertainty arising from an indeterminate amount of rock excavation, the full extent of which can be definitely ascertained only as the work progresses. A slippery underlying bedrock, causing the ground from above to slide down into the ditch; a springy soil, rendering it difficult to make the ditch-bed solid and keep it in place, are also to be enumerated among the troubles that cannot well be foreseen and guarded against at the start.

The entire cost of all the mining ditches heretofore constructed in California approximates, and may even exceed, thirty million dollars, not including those now disused or abandoned, of which there are a good many, some of them built at great cost.

How losses were incurred by the pioneer ditch builders in this State, through neglect of what would now be considered the most necessary precaution, is well exemplified in the case of the Truckee Ditch, constructed over twenty years ago by English capital, and which, after nearly a million dollars had been expended upon it, was finally abandoned, the investment, excepting a trifle afterwards realized from the sale of the company's water franchise, having proved an entire loss. This ditch was dug to bring water into Minnesota, Alleghany, and other camps on the divide between the Middle and the North Forks of the Yuba. Although it had capacity for carrying three thousand inches of water, it was, for its size, a costly concern. Along it were more than thirteen miles of flume, the most of it suspended from the rocky sides of a steep cañon. A capacious and expensive reservoir was built at its head, under the impression that the water requirements of the district to be supplied by it would be large and lasting, an expectation in which the company was disappointed, for, while the drift diggings and shallow placers had proved rich, there were no extensive hydraulic deposits in the district, hence but little demand for water; a neglect to determine this point in advance having been the fatal mistake that wrecked the enterprise. Many other failures as absolute as this, though not always so pecuniarily disastrous, occurred during the early history of ditch building in California. Some of these properties were repeatedly sold by the Sheriff to satisfy the debts that had accrued against them; each of these sales marking the lifetime of a new proprietorship and the end of an unavailing struggle to save the undertaking from impending ruin and the owners from bankruptcy. Of late years, however, fewer of these enterprises have proved failures, those undertaking them having been able to make their calculations with more certainty than was possible at a time when the prices of labor and material were inordinately high and so little was known about the resources and requirements of our mines, or other conditions essential to success.

LENGTH, CAPACITY, AND COST OF DITCHES.

The following table, containing the above data in regard to the principal ditches in the State, includes also cost of reservoirs in the instances mentioned. In some cases, what is given as the ditch length, includes two or three ditches belonging to the same company, all large and of nearly the same capacity:

Name.	Length in Miles.	Capacity in Miner's Inches.	Cost.
Auburn and Bear River Canal Company	75	3,000	$350,000
Amador Canal Company	66	2,000	400,000
Blue Tent	32	2,000	150,000
Brandy City	17	2,200	90,000
Buckeye Company, Trinity County	35	2,500	120,000
Cedar Creek, Dutch Flat	50	4,500	125,000
California Water Company	125	4,500	550,000
Dardanelles Company	17	3,000	125,000
Del Norte Company	10	2,000	40,000
Eureka Lake and Yuba Canal Con.	163	5,800	723,342
Excelsior System, Smartsville	110	5,300	1,000,000
El Dorado Water and Deep Gravel Company	26	5,000	650,000
Eureka Canal Company	170	2,000	650,000
Gold Run Ditch and Mining Company	26	2,500	150,000
Hendricks	46½	2,000	136,150
Iowa Hill Company	27	4,500	175,000
LaGrange	20	2,700	500,000
Little York and Liberty Hill System	35	3,500	150,000
Milton, with reservoirs	100	3,000	391,579
Mokelumne Hill and Campo Seco Company	55	1,200	500,000
North Bloomfield, with reservoirs	157	3,200	708,841
Natoma Water and Mining Company	16	3,500	390,000
Phœnix Ditch Company	100	4,000	880,000
Powers' Ditch, Butte County	30	2,000	75,000
South Yuba Canal System	123	7,000	800,000
Spring Valley and Cherokee	52	2,500	500,000
Tuolumne County Water Company	75	3,600	1,550,000
Trinity River Canal, in course of construction	35	10,000	80,000
Union Water Company	50	1,500	350,000
Totals	1,843½	100,500	$12,259,912

Besides the ditches included in the above table, there are five or six times as many others in the State, the most of them of small capacity. Connected with most of the larger ditches are one or more reservoirs, besides extensive tracts of mining ground, the latter varying in area from forty or fifty to as much as four or five hundred acres. The mineral land to which the Trinity River canal, owned by Thomas H. Blythe, is appurtenant, comprises seven thousand seven hundred and seven acres, the most of it held under United States Patent, and a large proportion being gold-bearing. Connected with this property is a franchise to the entire water flow of the East Fork of Trinity River, and several other large streams in the vicinity, amounting, when these streams run moderately full, to about sixty thousand miners' inches of water. Most of the water rights belonging to these ditch companies are very valuable properties, inasmuch as they are perpetual, and the water they cover will always be required for either mining or agricultural purposes, if not for both; in which view their value will not be likely to suffer depreciation in the future.

STORING AND DISTRIBUTING RESERVOIRS.

From the middle of April to the middle of November the rainfall is, as a general thing, inconsiderable in California. By the time these seven months are one third past, the most of the smaller streams have dried up altogether, and even the larger are so diminished in size that they can supply but little water to the ditches dependent upon them for replenishment. For the purpose of catching and storing the water while yet abundant, and thus prolonging the working season of the hydraulic miner, the plan of building large reservoirs has been adopted by all the leading companies having at the head of, or adjacent to the lines of their ditches, eligible sites for such structures, as the most of them have. Some of these reservoirs are works of great magnitude and importance—costly, capacious, and secure; those belonging to the North Bloomfield, the Milton, the Eureka Lake, and South Yuba companies being much the largest in the State. These receptacles are filled during the rainy season, or when the snow is melting on the mountains, at which times there is a great surplus of water, infinite quantities of it running to waste every year. Each of the companies mentioned, as is the case also with some others, has constructed several of these basins for the impounding of water, and which, with their retaining dams, form a very extended and perfect system of depôts, none of which, except in extremely dry winters, fails to get filled.

The most extensive and complete, as well as the most costly of these systems of waterworks, is that of the North Bloomfield Company, whose several reservoirs hold very nearly one billion cubic feet of water, the most of it being contained in the Bowman Reservoir, the lowest and largest of the group. The dam for retaining the water in these reservoirs have cost over a quarter of a million dollars. In the construction of the Bowman Dam, one hundred feet high, there were employed fifty-five thousand cubic yards—eighty-five thousand tons—of material, mostly rock, the outer walls being built of roughly dressed stone. The catchment basin that feeds this reservoir, covers an area of twenty-nine square miles, the annual precipitation on which, rain and snow included, averages about seventy-eight inches, three fourths of which runs into the reservoir. Being at an altitude of over six thousand feet above sea level, the snow falls here to a considerable depth in the Winter, and, lasting till the warm weather comes on, makes much Summer water. The Eureka Lake and Yuba Canal Company, by damming up the outlets to several small lakes, have converted them into capacious reservoirs, holding an aggregate of eight hundred and twenty million cubic feet of water, the several reservoirs of the Milton Company, in the same neighborhood, having a still larger aggregate capacity. The South Yuba Company have two extensive reservoirs, the one formed by damning up the outlet of Meadow Lake, and the other by a similar structure thrown across the outlet to Fordice Valley, the water catchment to the two covering over one hundred square miles. Several other companies have each one or more reservoirs of considerable capacity, and but for the provisionary supply stored in these immense magazines, the hydraulic mines would be doomed to inactivity during the later Summer and earlier Autumn months, the most favorable season for carrying on this class of mining operations.

Distributing reservoirs, though of inferior dimensions and not always indispensable in the case of the smaller ditches, become a necessary appendage to the larger ones, being located near the mine and there used to receive and hold the water from the ditch, ready to be let on and shut off as required. They also receive and retain the water when piping is suspended for the purpose of cleaning up, shifting the giant, making repairs, etc., which water would otherwise run to waste. There always is, or should be, a number of these minor reservoirs attached to every large ditch.

THE NORTH BLOOMFIELD TUNNEL AND ITS AUXILIARY SHAFTS.

The bedrock tunnels run for securing outlet to these deep-lying gravel channels vary in length, from five or six hundred to three or four thousand feet, the only one in the State having a greater length than this, being that of the North Bloomfield Company, which reaches the extreme length of eight thousand feet. As this enterprise, which had the benefit of ample capital and an able management, well illustrates the character of this class of improvements and the methods of their construction, a short description of the above work might not, in this connection, be out of place. Possessing a large area of gravel situate on a rich and extensive "dead river" channel, the owners of the North Bloomfield ground, some ten years ago, devised a plan for opening it up by means of a bedrock tunnel. With a view to prospecting this ground and ascertaining the position and depth of the channel, four shafts were sunk to bedrock. The first of these shafts, the only one that struck the main channel, disclosed a body of gravel two hundred and seven feet deep, of which the lower one hundred and thirty-five feet consisted of the blue variety, characteristic of the bottom strata of the old river channels, though these seldom occur of such thickness as here. From the bottom of these shafts some two thousand feet of drifts were run with the course of the channel, which was shown to be about five hundred feet in width. The gravel extracted from these drifts and shafts, twenty-one thousand six hundred and fourteen tons, yielded thirty-six thousand six hundred dollars in gold; the entire cost of this preliminary labor having been sixty-three thousand nine hundred and fifty-six dollars.

This data obtained, a tunnel was located and commenced. As a means of facilitating and hurrying forward this work, eight double compartment shafts were sunk along the line of the tunnel, one of these compartments having been used for hoisting and the other for pumping. These shafts, which are four and a half by nine feet in the clear, and heavily timbered throughout, stand from eight to nine hundred feet apart, and have an average depth of one hundred and ninety-seven feet. The hoisting and pumping machinery was driven by hurdygurdy wheels, eighteen to twenty-one feet in diameter, the water brought in heavy iron pipes from the company's ditch, having been delivered under pressures varying from two hundred and forty to five hundred and fifty feet.

For six thousand feet in from its mouth, this tunnel is six and one half feet high and six feet wide, the balance eight by eight feet. The work of excavation, performed mostly by machine drills, was advanced simultaneously from sixteen different faces, the total progress made having averaged over one hundred feet per week. The ground proved very wet, nearly five hundred thousand gallons of water having been raised every twenty-four hours. An average of one hundred and sixty men were employed on this tunnel for over two years; the entire cost of the work, including construction of shafts, hoisting and pumping, machinery, etc., having amounted to over half a million dollars.

The management of the enterprise was committed to Hamilton Smith, Jr., who, from its inception throughout, acted in the double capacity of superintendent and engineer.

OTHER EXTENSIVE TUNNELS.

While the above described is much the longest, as well as the most costly, tunnel in the State, there are still a number of others, each ranging from three to four thousand feet in length, and some of which have cost at least half as much as that of the North Bloomfield company.

The Gold Run ditch and mining company, Placer County, have completed a system of bed-rock tunnels, eight feet by ten, and aggregating over four thousand feet in length. The Cedar Creek company, at Dutch Flat, in the same county, have well advanced the construction of a similar system of tunnels which, when completed, will aggregate a length of nearly four thousand feet. At the Nevada mine, near You Bet, Nevada County, a bed-rock tunnel, nearly three thousand feet long, was driven several years ago. For opening up the leading hydraulic mines at and around Smartsville, Yuba County, several tunnels of this kind, running from two to three thousand feet in length, have been excavated. Though run with the diamond drill, their construction was, in every instance, attended with heavy expense, the bed-rock in that district being exceedingly hard.

The cost of these structures varies everywhere with length, size, and the character of the rock to be penetrated, running all the way from twenty to sixty dollars per linear foot. The drilling in these tunnels, formerly done by hand, is now performed by power-driven machines, the Burleigh drill, propelled by compressed air, being the machine most in use.

Except where the bedrock is so hard that it will not readily wear into holes, sluices are laid down along the entire length of these tunnels. Eighteen hundred feet along the upper end of the North Bloomfield tunnel has been set with block-paved sluices, the balance, a tough slate, having been left bare.

BLOWING UP THE HIGH BANKS AND THE HARD GRAVEL WITH POWDER.

Where the gravel to be handled is found so hard that it cannot be easily piped down and disintegrated with water, and when in the progress of washing the banks become so high that they cannot be run off with convenience and safety, the plan of breaking them down and shattering them to pieces with powder is resorted to. This mode of dealing with these deposits, when the above untoward conditions supervene, was first introduced in 1860 by James P. Pierce, an experienced and successful hydraulic miner, and a pioneer in the business. Prior to the above date the gravel banks were caved down by being undermined with picks, a tedious and dangerous method, the standing mass sometimes giving way suddenly and burying up the workmen. Having conceived the idea that this work could be accomplished at less cost and with greater safety to human life by means of gunpowder, Mr. Pierce proceeded to test the matter in a practical manner. The experiment, though conducted in a comparatively small way, was attended with such satisfactory results that the new plan soon came into general use. The charges, small at first, were gradually increased as the utility of enlarging them became apparent, and such progress had been made in this direction, that in the course of ten years as much as fifty thousand pounds of powder had come to be fired at a single blast, the introducer of this method having, in the month of December, 1870, exploded that quantity in the Blue Point Gravel Mine, near Smartsville, where his first trial was made.

Where the material to be broken up presents a flat surface, instead of a perpendicular bank, or the body of gravel is quite shallow, a vertical shaft is sunk into the mass to a depth of fifteen or twenty feet and a small chamber excavated at the bottom of it. Into this chamber five or six kegs of powder are placed, thoroughly tamped and fired by electricity. A blast of this kind will pretty thoroughly shake up an area of ground from thirty to fifty feet in diameter.

Where recourse is had to drifts, a main adit is run in for a distance one and a half times as great as the height of the bank to be broken down. From the inner extremity of this adit, and at right angles with it, cross drifts are driven, their united length equaling that of the main adit. Occasionally the cross drifts are turned at their ends and run for a short distance parallel with the main drift, forming a perfect T. Where very large quantities of powder are to be used, a second and shorter set of cross drifts, half way between the first and the face of the bank, is sometimes run. Generally, however, a single set of drifts of this form (T) is considered sufficient. The quantity of powder required for a charge depends on the kind employed and the hight and hardness of the bank to be shattered, two thirds of a keg of blasting powder per one thousand cubic feet of gravel covered by the drifts being, as a general thing, sufficient. If enough is used to blow out the bottom gravel, the line of least resistance, the mass above, falling by its own weight, must be pretty effectually crushed, where the bank to be shattered is from eighty to one hundred feet high. Where the bank to be shattered is one hundred feet high, the main drift should be at least one hundred and twenty feet long, and always in about that ratio, so that the top pressure may be proportionate to the lateral or front pressure, and a general upheaval, instead of a blowing out of the front, or but a partial blowing up of the top, may ensue. These drifts are made no larger than the convenience of the workmen requires, being usually about three by four feet. Of the Judson powder, an explosive that is coming into extensive use for bank blasting, a much less quantity suffices than of ordinary black powder. The Judson powder is, by many experienced miners, preferred to every other, being recommended both for its greater economy and efficiency. Giant powder has occasionally been used for bank blasting with good effect. Where it is employed, each separate lot must be closely tamped, so as to wholly exclude the air. Though much more expensive, one pound of this powder will do as much execution as five or six pounds of ordinary powder.

In charging the drifts, the kegs or boxes of powder are placed along them in rows. The tops of the middle row of packages, whether kegs or boxes, are then removed, and two wires laid along them and connected with others that extend to the electric battery with which the explosion is effected. From eight to twelve electric fuses are equally distributed and buried in the powder. Where the Judson powder is used, the exploders are inserted in giant powder caps and laid on top the paper covering by which this explosive is protected from moisture.

FIRING THE BLAST, AND ITS EFFECTS.

The powder having been properly disposed of and the wires and fuse adjusted, a bulkhead of timbers is placed across the main drift at the point where the lateral arms intersect it, after which it is tightly packed to its mouth with sand and gravel, experience having shown that the tamping should be effectually done. Everything having been thus gotten in readiness, the conductors are connected with the electro-magnetic battery placed at a safe distance. A few turns of the crank, and instantaneously the entire mass of powder is exploded. The report that follows is not loud, nor is the concussion violent, the latter being deep and far-extending, like the shock of an earthquake. The surface of the mined ground lifts a little, the lower portion being thrown outward, after which the whole settling with a heavy thud, moves and crumbles for some moments, great clouds of dust mingled with powder fumes ascending meantime and obscuring the atmosphere. With such safety are these operations conducted, that no fatal or even serious casualty has ever occurred in connection with them.

The following examples of blowing up gravel banks with powder and their results, are here alluded to not because the list includes all or even a small portion of the heavy blasts that have been fired in California, but for the reason that they cover a considerable period of time, represent a number of widely separated localities, and fairly illustrate the mode of procedure as well as the effects generally produced by this class of operations.

The fifty thousand pound charge exploded in the Blue Point mine, in December, 1870, consisted of black powder, and was the largest that, up to that time, had been set off in the State. The underground passages excavated for receiving the powder on that occasion were composed of a main drift two hundred and seventy-five feet long, and four cross drifts, fifty feet apart, and each having a short arm, eighty feet, and a long arm, one hundred and twenty feet in length, the height of the bank being seventy-three feet. These drifts were of uniform size, three feet by four. The powder having been evenly distributed throughout the drifts, and the heads removed from the kegs, a cartridge was inserted in a keg of powder in each of the cross drifts, making ten points at which the charge was fired simultaneously. The blast was discharged by a galvanic battery, the wires extending along the main drift having been carried through each of the lateral drifts, passing in along one side and out along the other, connecting in their passage with the cartridge placed in each drift. The quantity of earth loosened up and brought into good condition for piping by this blast, amounted to one hundred and fifty thousand cubic yards. Again, in 1877, nearly eleven hundred kegs of powder were in like manner exploded in this mine, and with equally good effect.

In 1872, three thousand five hundred pounds of Giant Powder, No. 2, were fired in the Harriman and Taylor claim, at Gold Run, Placer County, throwing down and disintegrating two hundred thousand cubic yards of gravel. At the Paragon mine, near Bath, in the same county, a blast of seventeen thousand five hundred pounds of common black powder was shot off in 1874, doing good execution, some two hundred thousand dollars having been extracted from the gravel broken up by it. The drifts run for the reception of this powder amounted to three hundred and twenty-five linear feet. From the inner extremity of the main adit, which was one hundred and ten feet in length, an arm was extended in one direction seventy and in the other sixty feet. From the end of the former a drift was run toward the face of the bank fifty-five feet, and from the end of the latter a like drift was run thirty feet. In the longer drifts run to the right of the main tunnel, there were placed four hundred kegs of powder, and in those to the left three hundred kegs. The main tunnel was tamped for a distance of seventy-five feet in from its mouth, and the lateral drifts each ten feet. The entire set of drifts was four and one half feet high and five feet wide, the bank above being one hundred and fifty feet in height. The electrical machine used for firing this blast was placed four hundred and fifty feet from the mouth of the tunnel, the length of wire laid down for making the circuit amounting to one thousand five hundred feet.

The Nevada Reservoir and Ditch Company, operating at Sucker Flat, Nevada County, put off, in the early part of January, 1879, one thousand boxes—fifty thousand pounds—of Judson powder, disrupting and thoroughly loosening a bank of auriferous gravel two hundred feet high. From the gravel broken up there was subsequently washed out one hundred and fifty thousand dollars. The charge here employed would equal in force about one hundred thousand pounds of common blasting powder.

In the month of November, same year, there were exploded at a single blast, in the Dardanelles Hydraulic and Drift mine, near Forest Hill, Placer County, thirty-six thousand pounds of Judson powder, whereby some five hundred thousand cubic yards of cemented gravel were lifted up and shattered to pieces. Into the face of the bank, which was about one thousand feet long and one hundred and seventy-five feet high, there were driven five parallel adits, across each of which there were carried two or more lateral arms, the whole amount of drifting having reached a linear extent of one thousand two hundred feet. The powder, divided into lots weighing from one thousand to one thousand five hundred pounds each, was deposited in twenty-eight different chambers, into each of which were placed three exploders, all connected by insulated copper wires with the outside wires leading to a large electro-magnetic battery, set on a slight eminence, about two hundred feet from the face of the bank. In the month of May, 1880, Superintendent Waldeyer set off in the Spring Valley mine, at Cherokee, Butte County, twenty-five thousand pounds of Judson powder, which performed its work well, doing all that was expected of it.

In the Blue Tent mine, Nevada County, there were consumed in the course of the year 1880 a total of sixty thousand pounds of black, and four thousand pounds of Giant powder; there having been fired there during the year two blasts, at each of which there were burned twenty-five thousand pounds of black powder. In the early part of 1881, this company blew up a gravel bank nearly two hundred feet in height, using for the purpose one thousand seven hundred and twenty kegs of black powder containing twenty-five pounds each, a total of forty-three thousand pounds.

The foregoing examples, not to mention many others of like import that might be cited, serve to show the progress made in the use of these various explosives for shattering the indurated gravel deposits in California, and the extensive scale on which these disrupting agents have come to be employed for that purpose.

DISPOSING OF THE HIGH GRAVEL BANKS IN BENCHES.

As washing progresses, the gravel banks, through the pit being advanced into the hill or opened downward, become often so high that the entire mass cannot, at a single operation, be piped down with economy of labor or safety to the workmen. Where this occurs the bank is disposed of in benches, the upper half being first attacked and run off, and the balance afterwards. When the bank gets to be much over a hundred and fifty feet high, this is usually the method adopted for handling it. In many localities the banks of gravel in the course of washing come to be as much as two hundred and fifty or three hundred feet high. At a number of places on the Forest Hill Divide, about Gold Run, Dutch Flat, and You Bet, at North Bloomfield and elsewhere along the San Juan ridge, also around Smartsville and at Cherokee, Butte County, the hydraulic deposits run from one hundred to three hundred feet in depth. At some points in Trinity County they reach even a greater depth than this. On Buckeye Mountain, a high ridge lying between Stewart's Fork and Rush Creek, in that county, the gravel is supposed to be fully five hundred feet deep, and slightly auriferous throughout. Where this material reaches such extreme depths, the bulk of it is very apt to be of rather low grade.

Since the adoption of this plan of running off the high gravel banks in benches, accidents, in consequence of their caving and burying up the workmen, have rarely happened, though before this such casualties were of frequent occurrence.

VARIOUS MINOR MECHANISMS AND DEVICES.

The plan of filling reservoirs and then hoisting the gates and letting the water escape in a flood, as practiced by the ancients, has its counterpart in the "self-shooter," so called, a contrivance through the use of which the opening and shutting of the reservoir gate becomes automatic. These devices are in use in some of the northwesterly counties of California, and still more extensively in certain parts of Colorado, where this method of collecting and discharging water is called "booming," an appellation more expressive of the manner in which the machine does its work, and less suggestive of suicidal intent than the name given to it in California. This self-acting gate, which is not much employed, except in localities where water is scarce and labor requires to be closely economized, may be described as follows: To the upper edge of the gate, which consists of a heavy piece of canvas, a rope is attached that passes up over a five foot pulley fixed above the dam, and thence back fifteen feet over a much larger pulley, dropping down from which its end is fastened to a large wooden box or cistern. A small flume extends from the upper edge of the reservoir to this box; when the reservoir is full, the water flows out through the flume into the box, which, as it fills up, moves downward, raising the canvas gate and letting the water out into a race which carries it down to the mine. Meantime, the water in the box having escaped through holes in the bottom made for the purpose, the box ascends, being raised by a weighted lever attached to the axle of the smaller pulley. With this action, the canvas gate drops again to its place and the flow of water being here arrested, the reservoir fills up, once more repeating the process above described. The advantages of this mode of "booming" are, that all the water is saved, while the services of a gate tender are dispensed with. The above is the style of this device as rigged up in Colorado, a long sweep and wooden gate being, in California, substituted for the canvas gate, rope, and pulleys, the latter much the better arrangement.

Besides these more costly and powerful methods, appliances and improvements, as hereinbefore described, many others of minor importance, but all more or less useful, have, from time to time, been introduced into the business of hydraulic mining. Among these devices of secondary consideration the following may be cited as constituting some of the more noteworthy, viz.: the hydraulic elevator, through the agency of which the water, under great pressure, besides being used to break down and wash the gravel, is also made to force it up through an iron tube to heights proportioned to the amount of pressure and the volume of water at command, the lift, through the more recent and improved machines being at the rate of about thirteen feet vertical for every hundred feet of pressure employed.

This machine is especially serviceable for utilizing the gravel on low flats and bars lacking dump; also, gravel resting in deep basins devoid of outlet, and which could not otherwise be worked except by the aid of long tunnels driven through the inclosing rim-rock. A number of these elevators are now running in different parts of the State, the most of which, accomplish their work, where properly managed and the conditions are favorable, in a satisfactory manner.

In this category we have also the various styles of the machine drill, by means of which long drifts and tunnels can now be driven at much less cost than formerly, effecting what is hardly less important, a great economy of time, as well. The substitution of the electric light for the pine torch and bonfire of other days, has much advantaged the companies adopting it. The introduction of the telegraph and the telephone is proving a great convenience to the many large hydraulic and drift companies who have furnished their works with one or both of these methods of rapid communication.

But lack of space forbids further enlargement of the list of these auxiliaries which have enabled the hydraulic miner to so largely reduce his expenses, increase his revenues, and add to the security of life and limb, while they mitigate the severity of his labors.

Whole chapters might be written on some of the powerful implements and inventions that in the foregoing pages have barely been mentioned, to say nothing of others almost equally deserving that have not even been alluded to; but as we have so overlooked much of the effective enginery that the hydraulic miner has called to his aid, so also has nothing been said of the many novel contrivances and worthless machines with which he has one time and another been induced to experiment, to the great detriment of his business and the depletion of his pockets.

It is the case, however, that this department of mining, while it has, like every other, suffered all too much from the presence of the pretentious and visionary inventor, has been spared the machinations of the "process fiend," who has more generally sought his victims among that unhappy class of men known as "base ore miners."

Before closing this branch of our subject, a few additional remarks, accompanied with some tabulated matter in regard to the yield of gravel, product of leading mines, etc., will be submitted; some portions of this data having been taken from the statistics compiled at various times by Walter A. Skidmore; some, also, from the standard work of A. J. Bowie, already alluded to.

The appended tabulated statement shows, in so far as the facts in each case could be ascertained, the average height of the gravel banks washed; pressure under which the water was used; number of cubic yards gravel run off; cubic yards moved per miner's inch of water, and the yield per cubic yard of some of the leading and a few of the smaller hydraulic mines scattered over all parts of the State; the object being to present a fair average of this class of facts. These estimates extend in some cases over a period of fifteen or twenty years, while in others they cover a much shorter period of time:

Company or Claim.	County.	Average height of bank in feet.	Pressure in feet.	Cubic yards washed.	Cubic yards moved per Miners' Inch of Water.	Yield.	
						In Cents per Inch of Water.	In Cents per cubic yard.
American	Nevada	120	250	6,000,000			24
Blue Tent	Nevada	180	300	8,000,000			15
Blue Gravel	Yuba						63
Blue Point	Yuba			133,000			123
Brandy City	Sierra	27					110
Columbia Hill	Nevada	110	325	33,700,000	5.00	27	4½
Chesnau	Stanislaus	28	70	284,932	1.37	23	16
Dardanelles	Placer	175	300	23,000,000	4.00	52	13
Enterprise			325		5.61	49	
French Corral	Nevada	175	230		1 1/16	45	40
French Hill	Stanislaus	30	60	676,968	1.08	14	13
Gold Run	Placer	220					5
Hobson			360		.20	70	
Johnson	Stanislaus	30	80	196,632	1.76	08	4
LaGrange	Stanislaus	15 to 90					3 to 12
Light	Stanislaus	45	60	683,244	1.80	12	6½
Milton	Nevada	160	220				
Manzanita	Nevada	140	275		1 1/5	34	30
Morning Star			450		5.61	37	
North Bloomfield	Nevada	180 to 260	310	37,000,000	5.05	30	5½
Orion			275		10.19	50	
Pactolus	Yuba						20
Prichard			150		2.73	26½	
Patricksville	Stanislaus	50					5 to 15
Smartsville	Yuba	112					19
Spring Valley	Butte	300	275	10,500,000			28
Sicard	Stanislaus	90	90	155,347	2.89	37	13
Union	Yuba						15

While the above table is so very incomplete, much of the data given is the result of mere estimates or conjecture, so difficult is it to acquire reliable information or make definite calculations in regard to this class of facts. To any general rule laid down there are so many exceptions that its indiscriminate application is almost as likely to mislead as to enlighten us. For example, if it be given to determine the quantity of gravel standing in place, or that may have been run off from a certain area, the estimate between the inequalities of the surface above and of the bedrock below, becomes often mere matter of guess work. We go on talking about what an inch of water will accomplish, without always knowing within ten or fifteen per cent. what quantity of water that is. And so on of many other calculations in which the determining factors themselves are vague, fluctuating, and indeterminate.

Without attempting, then, to further tabulate this sort of information, the following statements will serve to dispose of some remaining data, all accurate enough so far as they go, but general in their application:

VALUE OF GRAVEL PER CUBIC YARD.

As Mr. W. A. Skidmore, who has written much and very intelligently on this subject, justly remarks, the profits of hydraulic mining do not depend so much on the value of the auriferous gravel as on the facilities enjoyed for moving and washing it; loose top gravel that yielded no more than three cents per cubic yard having been worked with fair profit where the operator owned the water and the other conditions were generally favorable. A number of claims belonging to the LaGrange Company, in Stanislaus County, though their record of production shows a grade of gravel considerably below the average, have still proved moderately remunerative to the owners. Forty three millions cubic yards of gravel washed at Gold Run prior to 1874, yielded a total of two million one hundred thousand dollars, hardly five cents per cubic yard. But the stratum here run off, which was about one hundred feet deep, consisted of loose top gravel, requiring but little water to move and wash it. From the first this gravel increased slightly in richness, as it will continue to do until within twenty or thirty feet of the bottom, when this increase will be more marked, the two or three feet next the bedrock containing usually great quantities of gold. There remains here still some two hundred feet of gravel, which, while it will cost a great deal more to be worked, will yield three or four times as much as the stratum already run off.

On the San Juan Divide the gravel worked, top and bottom strata all included, has yielded an average of twenty-two and one half cents per cubic yard, the product of the Forest Hill Divide having averaged as much, or perhaps a little more. In the vicinity of Dutch Flat, Little York, and You Bet, the average has been about seventeen cents, but here not much of the richer bottom gravel has yet been worked. Up to 1874, there had been washed off, in the neighborhood of Smartsville, twenty-five million cubic yards of gravel which produced six million dollars, being twenty-four cents per cubic yard. The hydraulic mines tailing into Klamath and Trinity rivers and their tributaries, present the best examples we have of a well sustained high rate of production over a wide extent of territory, the yield of these mines having averaged fully thirty cents per cubic yard. But the gravel banks in that section of the State are not deep, hardly more than fifty feet on an average.

PER INCH OF WATER.

As a standard for measuring the value of hydraulic gravel, the miner's inch has, of late years, begun to supersede the cubic yard formerly employed for that purpose. The quantity of gravel that can be moved with an inch of water depends on the hardness of the gravel and the amount of pressure under which the water is used. Under a pressure of two hundred and fifty feet, an inch will wash from one and a quarter to four cubic yards of ordinary gravel. At the North Bloomfield mine, nineteen cubic feet of water runs off one cubic foot of solid gravel (that company having, in the year 1879, consumed over fifteen thousand million gallons of water.) In Trinity, Siskiyou, and Del Norte counties, a miner's inch of water usually washes from two and a half to three cubic yards of gravel, top and bottom included.

PER ACRE.

The quantity of gravel standing on an acre varies, of course, with its depth, which, as we have seen, ranges from twenty or thirty up to three and four hundred feet. On an average, an acre contains about one hundred thousand cubic yards.

It is often the case, however, that what is lacking in depth is made up in richness, a shallow stratum containing sometimes more gold than others much deeper. The hydraulic gravel banks of Stanislaus County, so far as worked to bed-rock, have yielded at the rate of five thousand two hundred and sixty-three dollars and fifty cents per acre, while those in the north-western counties have yielded at about double that rate. A bank of gravel forty-five feet in height, that will yield at the rate of seven and one quarter cents to the cubic yard, will give a gross product of five thousand two hundred and sixty-three dollars and fifty cents per acre, and can, therefore, with ordinary facilities, be worked with profit.

DRIFT MINING.

This term, as has already been explained, is used to designate that mode of operating whereby the deposits of auriferous gravel are reached by means of shafts, inclines, or tunnels, and, having been dug or drifted out, are afterwards, through these openings brought to the surface and washed in sluices; the methods here in use being similar to those employed in coal mining. As in the latter, we have in these drift diggings galleries and gangways, adits and shafts, either horizontal or inclined, with a variety of other aids and appliances common to both. In both the contents of the mine lie flat, or nearly so, necessitating roof supports, while in both these contents are broken out mostly with the pick and gad, and removed to the surface in cars run over tramways.

Whether a deposit of auriferous gravel is to be worked by the hydraulic or the drift method, depends on the following considerations: first, the manner in which the gold occurs—that is, whether it is mostly confined to the bottom stratum, or whether it is generally distributed throughout the entire bank, or a large portion of it; also, whether there is, superimposed upon the deposit, any large amount of lava or other hard and barren matter, and, finally, the facilities that exist for outlet or dump, and the quantity of water easily available for washing purposes. However much gold the gravel bank may contain, in the aggregate, if diffused throughout the entire mass —if the pay dirt is covered up with great quantities of worthless material, if there is lack of fall below the mine or an insufficiency of water for working it, the deposit will have to be worked by the drift method, or if undertaken by the hydraulic the enterprise must result in early failure.

In hydraulic mining, as we have seen, the entire body of auriferous gravel is broken down and run off, nothing but the larger bowlders, with occasionally some masses of pipe clay, lava, or other barren and unwieldy material being left behind. In drift operations, on the contrary, only a thin stratum of the rich bottom gravel, from three to five feet in thickness, is ever taken out or at all disturbed, it being in this stratum that the most of the gold is found.

EARLY HISTORY OF THE BUSINESS—THE FATAL MISTAKES THAT LEAD TO MANY FAILURES.

Tracing this style of mining to its incipiency, we find its origin in the practice, early begun, of following the rich streak of gravel under the river banks by means of rude excavations, supported mostly by bowlders, which manner of searching after and gathering gold was, in the not very elegant vocabulary of the day, denominated "Coyotying." Not, however, until about 1852 or 1853 did operations by this method take the form of a distinctive branch of mining; the discovery of the old river channels about that time having opened a wider field and imparted to it an unwonted activity. Spreading rapidly, great numbers of shafts and tunnels were started along these old channels, western Sierra, central Nevada, and some portions of Placer and Tuolumne counties having been the sites of most of these works, sixty per cent. of which brought only disappointment to the projectors, more than a third of all undertaken having proved signal failures. These failures were, as a general thing, caused by the tunnels run for opening up and draining this class of claims, having been driven on levels too high to effect these objects. At that day the plan of putting down shafts to ascertain the position of the deposits and thoroughly determine in advance the proper level on which to run the tunnel, had not yet come in vogue. As the further up the slope of the hill these tunnels were located the shorter they would require to be, the miners, through their desire to economize time and expense by making them as short as possible, were apt to be betrayed into the fatal mistake of locating them too high, a mistake that cost many of them very dearly.

As capital had not thus early begun to embark in enterprises of this kind, these exploratory works were mostly undertaken by the miners themselves, who, in carrying them on, proceeded after something like the following plan: Small companies, usually from ten to twenty, entered into a partnership with a capital stock consisting of a limited number of shares, not more, perhaps, than three or four times as many as there were members in the company, each of whom took at least one share, such of them as had money taking two or more, according to their means. With the money realized from the sale of these shares, work was carried on as long as the funds lasted; when exhausted, the whole company, or a part of it, would break off and hire out, or perhaps work some claim they might have in the neighborhood and earn money enough to keep up or resume operations on the work in hand.

With means so limited and liable to so much interruption, the business of driving by hand drilling long tunnels through the hard rock was necessarily a slow one, five or six, and often as many as eight or ten years having been consumed in the construction of one of these adits. Very severe, then, was the disappointment of these men, when, as so often happened, they found that all these long years and their hard earned money had, through the inutility of these structures, been spent in vain. By reason of these mishaps the business of drift mining was greatly retarded, and many a miner's purpose of making an early return to "the States" indefinitely postponed.

After a time, however, when these mistakes were fewer, the altitudes of the old channels having come to be better understood, this branch of mining began to pay better. For many years large returns were made along the channel reaching from Minnesota through Chipp's Flat, Alleghany and Forest City, and thence on via Monte Cristo, into Plumas County. Very prosperous diggings of this kind have also for a long time been worked along either side of Slate Creek, in Sierra County, as well, also, as at a number of other places in that vicinity. As a drift camp, Damascus, on the Forest Hill divide, has, for the past ten or twelve years, enjoyed a good reputation, there being a number of other places, both on that divide and elsewhere in Placer County, where the drift diggings are making satisfactory returns. Above Liberty Hill, along the ridge between Steep Hollow and Bear River, are several claims of this kind that are yielding moderately well. Some drifting is being prosecuted along Trinity River and at a few other points in Trinity County, but the business there, while paying fairly, has never been engaged in extensively or been marked by any very large success.

LOCALITIES OF DRIFT MINES AND THE MODES OF PROCEDURE ADOPTED IN EXPLOITING THEM.

As already remarked, no very extensive drift mining has ever been carried on elsewhere than along the channels of the "dead rivers" proper. Some drift operations have been prosecuted under the banks and bars of the present rivers, and along the buried side channels formerly occupied by these modern streams; but they have not been extensive, nor have more than a few of them ever proved remunerative, except along the Trinity and some other of the northern rivers, where the most of these undertakings have been attended with fair success.

Where practicable, a drift mine is always opened by means of a tunnel driven in from the side of the mountain or ravine where it is situated, and on a level, as near as it can be ascertained, with the bottom stratum of gravel, only fall enough being given to it to insure drainage. If the tunnel happens to be located too low, it necessitates a double handling of the gravel, which, after being brought out of the side drifts, has then to be dumped or dropped down into the cars run in on the main tunnel to receive it. If the tunnel be too high, then a winze or incline has to be put down from its inner extremity, and the gravel be hoisted in buckets through the winze, or be taken up in cars run on a tramway laid along the incline. If buckets are used instead of cars for bringing up the gravel, they are hauled up on slides, being pieces of square timber laid on the bottom of the incline a few inches apart, according to the size of the buckets used.

The tunnel, after having reached the channel, is continued up it, following its sinuosities and keeping as near the center as possible. As it is desirable to maintain the tunnel on a uniform level as nearly as may be, it is sometimes in bed-rock and sometimes in the gravel above, as inequalities in the channel are met with. From the central tunnel lateral tunnels or drifts are run off on either side at regular intervals, usually of sixty feet. These side tunnels are then connected by others run parallel with the main tunnel, whereby the body of the gravel to be removed is divided up into elongated squares and brought into suitable condition to be *drifted* or *breasted* out, as the miners variously term this style of stoping. Along these avenues, as drifting proceeds, car tracks are laid down, unless wheelbarrows are used for bringing out the gravel, as is the case where the quantity is small. As fast as the stratum of pay-gravel is removed the roof above is supported by timbers. As stoping advances the great weight of the mass above gradually settles down and closes up the excavation, this settling never taking place so suddenly as to endanger the lives of the miners. Occasionally the excavation is filled by the swelling of the bed-rock below, some of this material upon being exposed to the atmosphere expanding in a remarkable manner.

Owing to this singular property of certain rocks it frequently occurs that tunnels in other than the drift mines become wholly or partially closed up within a short time after they are driven. Serious difficuly has, on this account, sometimes been experienced in keeping open the tunnels on the Comstock mines, some of which, if neglected, would have closed up completely within two or three years after they were run, while access to others has been maintained only by cutting away the constantly swelling rock, the expansive power of which crushes often the strongest timbers.

As the settling down of the roof of the mine would necessarily destroy the main tunnel, if some provision were not made to guard against such result, a strip of gravel some thirty feet in width is left along either side of it, affording it the proper protection and support. When the mine is worked out and ready for abandonment, the workmen, starting at their inner extremities, drift out these remaining strips of ground, whereupon the unsupported mass above falls in, finally closing up the mine.

The length of time required for exhausting a drift claim depends on a variety of circumstances, such as the extent of ground to be worked out, facilities for getting out the gravel, number of hands employed, etc., the life of these mines enduring from six or eight to twenty-five or thirty years. Where a number of claims have been located on a strong and well defined channel, the course of which has been definitely ascertained, they are sometimes worked out in rotation, one company waiting till the next below them have exhausted their ground, when the parties owning above, instead of constructing a new tunnel, will acquire the right of way through the tunnel of their neighbors, who have for it no further use. Not often, however, has it been found expedient to so wait and attempt utilizing the same tunnel for opening and working more than one mine. But it is sometimes the case that no other outlet can be had for a mine than through the tunnel driven on the claim below. In some of the drift channels, the bulk of the gold is found within two or three feet, and occasionally even within one foot, of the bed-rock. When this is the case, not over three or three and a half feet of the gravel is removed, just enough to enable the drifters to perform their work conveniently. Generally from four to six feet of the bottom gravel is rich enough to warrant its extraction, though, in a few instances, it is taken out to a height of twenty-five or thirty feet. Rarely, however, is drifting carried to a greater height than five or six feet. The portion of these channels, measured transversely, that have proved rich enough to warrant being worked, have varied from forty or fifty to six or seven hundred feet, the average width being about two hundred and fifty feet. The labor force employed by the drift companies varies, of course, with the extent of the mine and the difficulties encountered in working it, ranging all the way from ten or fifteen up to one hundred and fifty, and occasionally as high as two hundred men.

As the number of drift mines now being worked in California is very great, notice can here be taken of only such as have been distinguished for their large out-put of bullion, the great cost of their exploitation, or the more than ordinarily good prospects that seem to await their future. Standing at the head of this category is

THE BALD MOUNTAIN MINE,

Located at Forest City, Sierra County, noted alike for its large and long continued bullion production, its liberal net earnings, and general good management, this company having conducted their affairs with excellent judgment, and been in "bonanza," with scarcely more than a year's intermission, for the past nine years. This mine is situated on and forms a part of the main "dead river" that traverses the country north through Minnesota, Forest City, and Monte Cristo, into Plumas County. The Bald Mountain Company own at this point a total of seven thousand five hundred linear feet, of which a little over four thousand feet have already been worked out. Up to August 1, 1880, there had been three thousand eight hundred and fifty feet of the channel exhausted, and from which there was extracted the sum of one million seven hundred and eighty-eight dollars, the yield having been at the rate of four hundred and sixty-four dollars per linear foot; cost of extraction per linear foot, two hundred and forty dollars; average yield, two dollars and seventeen cents per carload—one dollar and seventy-six cents per ton.

The following table shows the annual operations of the company from 1872, when they first began taking out gold, to August 1, 1880:

YEAR.*	Car Loads.	Gross Yields.	Per Car Load.	Dividends.
1872 to 1875	195,940	$544,000 00	$2 77	$284,000 00
1875 to 1876	100,080	296,341 76	2 96	150,000 00
1876 to 1877	98,044	235,803 57	2 40	70,000 00
1877 to 1878	106,160	269,755 00	2 54	120,000 00
1878 to 1879	90,274	164,909 00	1 82	40,000 00
1879 to 1880	86,378	188,892 40	2 18	60,000 00
1879—Oregon Creek		3,000 00		
Totals	676,876	$1,702,701 73	†$2 17	$724,000 09
July 1, 1880, to August 1, 1880		16,914 38		20,000 00
Totals to August 1, 1880		$1,719,616 11		$744,000 00

* Commences July 1st. † General average.

As this mine has, for the past eighteen months, yielded at a somewhat better rate than during the fiscal year ending August 1, 1880, the entire production made here may be set down at about two million dollars; profits disbursed in dividends, at eight hundred and fifty thousand dollars, with a corresponding increase in the average yield per car load. The following constitutes the items of expenditure made by the company to August 1, 1880:

Original outlay on shaft and tunnel	$20,000
Purchase of tailings—outlet, and disputed title	31,000
Working expenses to August, 1880	923,000
Total outlay	$974,000

The smallness of the sum set down in the above table to account of shaft and tunnel construction is explained by the fact that this company was originally made up of twenty practical miners, who, having themselves performed the most of this work, no charge is here made for the same.

Toward the end of 1877, this company lost their pay gravel, a basaltic dyke coming in and for a considerable distance completely obliterating the old river channel. This obstruction not only cut off their revenues, but forced them to perform, at great expense, a large amount of dead work, hence the reduced dividends paid during the several years following that date. Having carried a tunnel around this dyke, the pay channel was recovered and has since yielded better than before.

This company have now in their service about one hundred and twenty men, much fewer than before employing a locomotive for hauling in and bringing out their cars. Ordinary hands are paid three dollars per day, foremen, and those working in wet and dangerous places, from four to five dollars per day; the company's pay roll averaging about ten thousand dollars per month.

Appurtenant to this mine are two dump yards, the one capable of containing twenty-six thousand and the other sixteen thousand tons of gravel. Into these receptacles the gravel taken out during the dry season is deposited, awaiting such time as there may be water for washing it. The water for this purpose is supplied by Oregon Creek, which usually affords enough every Winter to wash the gravel that has accumulated the preceding Summer; occasionally, however, the supply is insufficient for this purpose, leaving on hand part of the last Summer's stock to be held over and washed the next year. To this circumstance is due, in part, the uneven annual productions observable in the foregoing table. The Bald Mountain Company, it is calculated, have enough gravel left within the limits of their claim to keep them profitably employed for another nine years at least.

REMOVING THE GRAVEL FROM THE MINE.

Where the gravel from drift mines is to be brought to the surface through vertical or inclined shafts, the kind of motive power to be used for that purpose depends on circumstances. If there is but little material to be brought out, it may be raised with a windlass worked by hand; if much, then horse, steam, or water power is employed; always the latter where it can be readily obtained, which, however, does not often happen. Where the gravel is removed through tunnels, no other force is required to propel the loaded cars, once they are on the main track, than their own momentum, the tunnel grade being usually such that specific gravity not only suffices to carry out the cars, but tends to so accelerate their speed that it has to be checked by means of brakes. In these cases, one man, unless the grade is very steep, brings out two or three cars, standing on the rear one, to which a brake is attached, and through the use of which the entire set is controlled. For returning the cars into the mine, men or draft animals, generally mules, are employed; workmen, timber, tools, etc., being taken in on the returning cars. With so many brakesmen and draft animals required for this service, a more cheap and convenient means for its performance has, in the larger mines, become a desideratum, which latter has in the case of the Bald Mountain Gold Mining Company been supplied through the employment of an underground locomotive, and with such satisfactory results that it may be expected other companies having large quantities of gravel to handle will have recourse to like means for its removal.

HISTORY AND CONSTRUCTION OF THIS PIONEER MACHINE.

While these underground locomotives are used in many coal mines, we have, probably, in the instance just cited the first example of one ever having been employed in a gold mine. Such being the case, some brief description of this machine and the manner in which it performs its work may not, to those concerned in drift mining, be without interest.

Impelled by the necessity alluded to, the Bald Mountain Company, in the Summer of 1876, determined to procure a locomotive to be used as a traction power in their tunnel. In furtherance of this purpose application was made to the Baldwin Locomotive Works, Philadelphia, for an engine to be propelled by compressed air, the company being then under the impression that a coal consuming machine would too much vitiate the air in their mine to admit of its use. On the recommendation of the Philadelphia builders, however, they concluded to accept an anthracite coal burner, one of which having been constructed, was by this company introduced into their mine and set to work in the following month of December, from which time to the present it has performed the service required of it in a manner wholly acceptable to the company.

Along the main Bald Mountain tunnel, now over a mile long, a twenty inch track with T rails has been laid down, and which, at some points along it, has nearly a four per cent. grade, the track raising at the rate of two hundred and twenty feet per mile. This tunnel is six feet high, five feet six inches above the rails. It is four feet wide on the bottom, its sides for eighteen inches up being vertical, whence they contract to two feet six inches in width at the top. Curves along the track vary from sixty to one hundred and fifty feet radius. The cars in use here run on wheels twelve inches in diameter, weigh seven hundred and fifty pounds, and carry two tons each. Formerly, owing to the steepness of the grade, one man was required to bring out and return each car.

The dimensions of this locomotive are as follows: Height, sixty-one inches; cylinders, eight inches by twelve; width across cylinders, 46.5 inches; width across tank, thirty-nine inches; diameter of driving wheels, twenty-four inches; wheel base, three feet four inches; tank capacity, one hundred and ten gallons; weight, all completed, fifteen thousand pounds.

With this locomotive, and without brakemen, using only the brake attached to it, a train of eighteen loaded cars is brought out from the mine in about five minutes; forty-five cars, carrying eighty workmen and twenty tons of material being returned by it in two minutes longer time. The output of gravel averages two thousand nine hundred and thirty-six carloads—five thousand eight hundred and seventy-two tons—per week. The cost of bringing out this gravel is given, by H. W. Wallis, Superintendent of the Bald Mountain Company as follows: By man power, twenty-one cents per carload; by mule power, nine cents per carload; by locomotive, four and three quarter cents per carload—two and three eighth cents per ton. The coal consumed by this engine amounts to four thousand three hundred and seventy pounds per week. With the method of ventilation here adopted, the gas and steam created by this consumption of coal, have no appreciable effect upon the atmosphere of the mine. For promoting ventilation, a two-compartment shaft has been sunk to the tunnel level, at a point two thousand feet in from its mouth. Down the center of each compartment, two inches of water are dropped, forcing with it such a current of air as serves to keep the mine well ventilated.

From the foregoing, it is evident that this style of locomotive could be employed to advantage by all drift companies having large quantities of gravel to remove through long tunnels and over steep grades. It is probable that it could be economically used in all tunnels over one thousand five hundred feet long, and so steep as to require a brakeman on every car brought out.

PRODUCTIVE LOCALITIES AND PECULIAR CONDITIONS.

Everything considered, Sierra may be accounted the foremost drift mining county in the State, the business having been commenced here at an early day and been actively and extensively prosecuted ever since. The drift claims worked here for the past thirty years, mostly in a small way, can be numbered by the hundred, the sites of greatest activity in this line of operations being Slate Creek basin and the several Old River channels running nearly parallel with and at a short distance to the east of it.

One reason for so much attention having been directed to this branch of mining in Sierra County, is found in the fact that a very large proportion of the gold-bearing gravel there has been covered so deeply under volcanic flows that it can be utilized by no other method. Only in the western part of the county, as in and along the Slate Creek basin and about Brandy City, has this material been so denuded of its volcanic covering that it can be handled by the hydraulic process to advantage. But, while so restricted in area, the hydraulic workings in this county have almost always been attended with profit, and, in many instances, proved largely remunerative, few hydraulic mines in the State having paid better than those about Howland Flat and La Porte. The Zellerbach hydraulic mine, at Brandy City, has also a specially good history, both the rich channels that have so fertilized the Slate Creek diggings uniting above and passing through this ground.

While drift mining in Sierra County was for a long time at first attended with very uneven results, there have, of late years, occurred here but few signal failures in this line of business.

A MINE THAT WOULD NOT PAY WHILE OWNED RY ENGLISHMEN.

The only recent enterprise of this kind set on foot in Sierra County in which much money has been lost, was that embarked in by a syndicate of English capitalists, who some eight or nine years ago bought the North America mine, consisting of several large claims situate near Whisky Diggings, paying therefor the sum of four hundred thousand dollars. After holding and working the property for several years, during which it failed to pay current expenses, the unfortunate investors disposed of it for sixty thousand dollars, losing by the transaction three hundred and forty thousand dollars, besides interest on the purchase money. Immediately after this property passed out of the hands of the English company it began to pay largely, and has so continued to do ever since, being to-day considered one of the most valuable drift mines in Sierra County. Why this mine failed to pay while under English ownership we are not advised, opinions differing as to whether the causes of failure pertained to the mine or rested with the management. George D. McLane, and other experts, were severely, but, as it now appears, unjustly, censured for their favorable reports on this property prior to its purchase by the English company, the deposits here having proved to be fully as rich and much more extensive than represented by these parties.

Leaving these unconscionable promoters to answer to their clients for such unconscionable grab, and the above awkward interregnum in the prosperity of this mine unexplained, we proceed to notice some few other enterprises here that, because of their exceptionally good or bad record, seem entitled to special mention; remarking also on some of the general features and results that have characterized drift mining in this and adjacent counties.

FROM MINNESOTA TO FOREST CITY.

The pliocene channel that extends between these two places, passing, on its way, through Chipp's Flat, Alleghany, and West Ravine, has been very nearly worked out, its exploitation having been effected by long connecting tunnels, the most of which were extended clear through the ridges that severally separate the above named places. Some of these tunnels were over a mile long, their aggregate length having amounted to four or five miles. This channel paid almost every foot of the way, and at many spots, very largely. There is still a little work being done on some of the claims along it, also on branch, or side channels in the vicinity, some of the latter showing valuable deposits of auriferous gravel.

RESULTS OF TEN YEARS IN SIERRA COUNTY.

The following table compiled by E. S. Thurston, Mining Engineer, shows results reached in several of the moderately prosperous drift mines of Sierra County, during a period of ten years prior to 1875:

Mine.	Length of location—feet.	Yield per linear foot.	Total yield.
Union	2,400	$625 00	$1,500,000
Hawkeye	800	437 50	350,000
Pittsburgh	860	506 00	420,000
Monumental	1,040	312 00	325,000
Empire	1,500	482 05	752,000

PLACER COUNTY—THE OLD CHANNELS ON THE FOREST HILL DIVIDE.

Next to Sierra, Placer is the most noted drift mining county in California; the Forest Hill divide, the high ridge that separates the Middle from the North Fork of the American River, being the most active drift locality in Placer County. As already stated, the pliocene channels are numerous on this divide, forming here an extended and complicated system, the various ramifications of which have, as yet, been but partially traced out. The channels here, so far as worked, have in many instances been distinguished for their great breadth as well as their affluence. It was to the demolition of these dead river channels that the North and the Middle Forks of the American River, and their tributaries were indebted for their extreme fertility. For many of the following facts pertaining to the ancient river system on this divide, the writer is indebted to Samuel T. Leet, formerly a member of the California State Senate, and who spent many years in this district engaged in various mining pursuits, during which he studied up this subject in a careful and intelligent manner.

According to Mr. Leet's theory, two main channels, a front and a back one, separated by a space of only a few hundred feet, came down this ridge from the northeast, there being also, at several points, evidences of a third channel lying back of these and still further towards the northwest. These channels make their first appearance at, or a little above the mining hamlet of Damascus, and disappear a short distance below Todd's Valley; the North Fork, and the deep gorge known as Humbug Cañon, having swept away their upper, and the Middle Fork their lower portions. Some considerable sections intermediate these points have also been eroded by El Dorado, Volcano, and other deep cañons that cut them at nearly right angles. The remains of the pliocene rivers here left, have a total length, meandering included, of about fifteen miles. Though exceedingly crooked, these channels have a general southwesterly trend, the entire set in this series having been formed, no doubt, by one and the same stream, through the shifting of its course at different periods. As none of these channels lie at the same altitude, the front being more than one hundred feet higher than the middle one, this stream must, at different times, have run on different levels. The bottoms of these channels, which suffer also some inequalities, are covered with gravel, soil, and volcanic matter, to an average depth of four hundred feet, the superincumbent mass varying in thickness from two hundred and fifty to seven hundred feet. They have an average fall of about fifty-two feet to the mile, the grade being somewhat irregular.

So far as exploited, the pay gravel in these channels presents itself in three distinct strata, one of no great thickness, but much the richest, lying on the bedrock; a second, ten to forty feet thick, lying about one hundred feet above; and a third, about twenty feet thick, lying from sixty to eighty feet still higher; the interstratified material consisting of cement, volcanic matter, soil, etc.

In the front or lower channel of the series above described, scarcely anything like a rim or wall can be recognized, the pay stratum of gravel being spread out over the bedrock like mortar, the layer feathering out at the edges. This stuff is without sand or grit, appearing to be a fine sediment brought down and left here to harden. It contains the bark, leaves, and fragments of the trunks of trees similar to those now growing in the neighborhood. Though it can be broken out with the pick, it is sufficiently firm to stand without timbering, and does not readily slack on being exposed to the air. While this is the richest stratum of the three, the next above has hardly ever failed to well requite the judicious expenditure of labor upon it. The upper stratum, having been but little explored, its value for working purposes remains undetermined.

Besides this series of channels, which constitutes here the main old river belt, a number of subordinate channels traverse this divide in different directions, enriching localities widely separated. One of these channels strikes through Yankee Jim's and Iowa Hill, and thence on north through Gold Run, Dutch Flat, and You Bet, forming a part of the main southerly branch of the dead river system as hereinbefore described.

A deep-lying channel, not as yet much developed, runs west from Damascus along the easterly slope of the divide, and about seven hundred feet below its crest. At Michigan Bluff, ten miles south of Damascus, are the remains of a broad and fruitful channel that appears to come in from the northeast. What seems a fragment of this channel has been left at Deadwood, five miles northeast of the bluff. At Last Chance, ten miles further south, several small channels can be readily traced, all having a westerly trend. A small channel puts out from Yankee Jim's running east toward Forest Hill. Though well defined and known to carry some gold it remains nearly intact; the only work done upon it being that performed by the St. George Company, who own an extensive claim upon it, which has been opened up by means of a tunnel over a thousand feet long, driven in from the south. The gravel taken out proved to be so hard that it required to be crushed, for which purpose the company put up a ten-stamp mill. The material was, however, of too low grade to warrant treatment by this method, which, after a short time, was abandoned; nothing having since been done with the mine. For improving the ventilation of this mine, the contrivance known as a water blast is employed. By this device a small stream of water is dropped some seventy-five feet through a vertical iron tube, falling into a tub at its lower end. Over this tub a similar but smaller vessel is placed upside down, the whole being so arranged, that the air forced down by the falling water, is retained in the upper tub while the water escapes. This air is then conducted through an iron pipe laid along the tunnel, and discharged into the underground works. This cheap and effective plan for introducing air into drift mines is availed of in most places where improved ventilation is called for and water can be conveniently had for the purpose, being used by the Bald Mountain and other leading drift companies.

At different points along most of the several channels described, considerable quantities of gravel have been run off by the hydraulic process, very little mining having been done of late years at Yankee Jim's, Iowa Hill, Forest Hill, or about Michigan Bluff, except by that method.

DRIFT OPERATIONS IN THE VICINITY OF DAMASCUS—THE MOUNTAIN GATE COMPANY.

The claim of this company is located close to Damascus, their tunnels opening into the ravine only a few rods below the town. As originally composed, this company was made up of twenty-one members, all working miners, each of whom owned one share, the stock of the company consisting of but twenty-one shares, which number has never been increased. In its organization and history this enterprise well illustrates the manner in which these associations of miners were formed and managed, though not often have they lasted for so many years, or reached such an evenly sustained and long continued success as in the case of the Mountain Gate Company, who have been working their ground steadily for more than twenty years, during all which time, with the exception of two or three years, the owners have realized from its earnings a handsome net income.

This company owns an extensive section of the auriferous gravel belt that, commencing at the town of Damascus, runs in a southerly course down the divide. For opening and working this ground, a tunnel was first driven in on the upper and front channel and extended nearly seven thousand feet. It well answered the above purpose for a long series of years, the pay gravel to an average width of two hundred and twenty feet, having been taken out through it for a distance of six thousand five hundred feet, when the channel was cut off by a lava flow. When this obstacle was encountered—several years since—the company drifted in various directions, in the hope of again striking the pay-streak of gravel. Disappointed in this, an incline shaft was put down eighty feet, when another channel of about the same width was struck. The gravel in this lower channel carries more and finer gold than the upper. It is also of a deeper blue color, and contains granite pebbles and bowlders instead of quartz, denoting an origin different from that in the channel above.

These two and a half years spent in hunting for a new body of pay gravel, constitute the only unprofitable period in the history of the mine. Since striking this new deposit, a tunnel has been run in on the lower channel, which, being connected through inclines with the upper, insure good ventilation to the mine. As these tunnels run down stream, they fail to drain the underground works, an end that is attained by means of a large overshot wheel placed at the inner extremity of the old workings, where a reservoir has been excavated in the cement. Into this all the water from above being collected, is used for driving the overshot wheel, which hoists both the loaded cars and the water from the channel below.

The labor force employed here averages about forty-five men, employed as follows: Thirty-six miners, two attendants on waterwheel, two car drivers, two blacksmiths, one carpenter, one gravel washer, and a Superintendent; several hands being employed during the Summer getting out timber, lagging, etc. This property, the barren years excepted, has yielded at the rate of about six dollars per day for each miner employed, or, as the miners term it, "to the pick," the total product made up to the end of 1881, amounting to about one million five hundred thousand dollars, of which forty per cent. was disbursed in dividends. The mine, during the early months of 1882, has made even better earnings than the above.

THE HIDDEN TREASURE,

Another representative mine of this class, is situate at Sunny South, a short distance southwest of the Mountain Gate, covering about ten thousand five hundred and sixty linear feet of the same channel. This, also, is an organization of working miners, being composed of thirty-six members, each of whom, in the first instance, owned one share. Their ground has been opened by a tunnel three thousand feet long, driven up stream from the face of El Dorado Cañon. This tunnel, which passes all the way through a soft slate requiring but little blasting, was run on contract, at three dollars and a half per foot, the company furnishing timbers and laying down car track, which brought the entire cost to about four dollars per foot. This tunnel, which is run under the channel, keeping about thirty feet below the surface of the bedrock, rises at the rate of about seventy feet to the mile, its grade corresponding with that of the channel. From this tunnel, uprises are made to the gravel above at intervals of one hundred and twenty-five feet, the gravel being blocked out by drifts into squares of that length. As the tunnel is kept as nearly as practicable under the center of the channel, these squares measure from two to three hundred feet across, the channel at this point varying in width from two hundred and fifty to six hundred feet, its average width being nearly four hundred feet. The stratum of gravel removed is between five and six feet in thickness; it is largely composed of quartz fragments and bowlders, some of it being so hard that it requires to be broken out with powder. Ever since gravel was struck in this claim, in the month of May, 1878, it has yielded steadily and at a remunerative rate, as will be seen from the following statement taken from the company's books.

Receipts.

1878—Gross yield	$61,205 92
1879—Gross yield	98,437 15
1880—Gross yield to May 1st	36,920 10
Total receipts	$196,563 17

Expenditures.

1878—Labor	$32,891 25	
Other expenses	8,345 92	
		$41,237 17
1879—Labor	$37,550 34	
Other expenses	7,867 60	
		45,417 94
1880—Labor, to May 1st	$14,394 45	
Other expenses	1,664 38	
		16,058 83
Total expenses		$102,713 94

Or 52¼ per cent. of product.

The corresponding profits were:

1878	$19,968 75, or 32.7 per cent. of product.
1879	53,039 21, or 54. per cent. of product.
1880 (to May 1st)	20,861 27, or 66.5 per cent. of product.

Therefore, the result of twenty-eight months of continuous working may be summed up as follows:

Total product	$196,563 17
Expenses	102,713 94
Profit about 47¾ per cent	$93,849 23

The value of the gold taken out here prior to 1878 amounted to fifty thousand seven hundred and nineteen dollars and eighty-nine cents; value of that taken out since May 1, 1880, to about two hundred thousand dollars; making a gross production to the close of 1881 of four hundred and forty-seven thousand two hundred and eighty-three dollars and six cents.

At the end of 1881, the company had exhausted about one thousand six hundred linear feet of their ground, leaving a reserve of nearly nine thousand feet. They employ about fifty men at two dollars and fifty cents per day, besides a number engaged in cutting timber and lagging, some twelve thousand timbers and eighty thousand lagging being used annually in the mine. An average of one hundred and seventy-five carloads of gravel, of about three thousand five hundred pounds weight each, are taken out here daily.

Two and a half miles further down the channel brings us to Turkey Hill, the site of the Weske mine, which, for a number of years, made a very large production at a comparatively small cost. In opening this ground a tunnel was run in from the southwesterly slope of El Dorado Cañon. When in eight hundred feet this tunnel struck a branch of the main channel, which, proving to be rich in gold, was worked out to its intersection therewith, a distance of two thousand five hundred feet. The main channel has also been worked quite extensively. While the Weske Company have, on the whole, made a great deal of money, the profits realized have been much less than they would have been but for the litigation in which the title to their property has been involved, interrupting work a large portion of the time. Relieved from these troubles, at least in part, the company is now working about thirty men, the daily product of the mine being at the rate of twenty dollars to the pick. The gravel now taken out is so hard that it has to be crushed; for this purpose a twenty-stamp steam mill has been erected on the ground, which puts through five tons of gravel to the stamp, daily—the stuff not requiring to be pulverized very fine. This gravel yields at the rate of ten dollars per cubic yard. Each drifter breaks out about two cubic yards per day. The cars used for conveying the gravel out of the mine hold one cubic yard each, those employed for bringing it out from the drifts to the main tunnel being smaller. Portions of the Weske grounds have been extensively worked by the hydraulic process. The company have large deposits of both hydraulic and drift deposits still remaining.

Three miles below Weske is the mining town and district of Bath, where both drift and hydraulic operations have, in times past, been largely engaged in, and where these industries are still carried on quite extensively, being now mostly in the hands of two or three large companies, of which the Breece and Wheeler is the principal. This company own here a large tract of gold-bearing gravel land, their claim, known as the Paragon, having a frontage of one mile on the main channel, across which it extends for a distance of one and a half miles.

They carry on both drift and hydraulic mining, the latter only during the Spring and early Summer, their water season being short. They obtain their water, for washing, from El Dorado Cañon, bringing it through a short ditch of no great capacity.

The gravel in this district is generally of good grade, but so indurated that the bottom stratum has to be blasted out and requires crushing, or long exposure to the atmosphere, before being washed, both of these methods being more or less practiced.

The appended exhibit of work done and results reached by this company for the time stated, was prepared by Walter A. Skidmore, and published in the recently issued report of the Director of the Mint, on "The production of the precious metals in the United States."

The ten stamp mill of this company, completed and started up in September, 1879, has a capacity of forty tons per day. The following is a record of a continuous run, extending from September 19, 1879, to April 14, 1880:

Car loads of gravel crushed	4,241
Total yield	$44,835 50
Average yield per car load	10 57
Average cost per car load, mining and milling	3 94

A car load here contains twenty-eight cubic feet, weighing about one and one half tons; the yield per ton was, therefore, seven dollars and five cents. This mill has ten stamps, weighing eight hundred and fifty pounds each, with steel shoes and dies, making eighty drops of ten inches per minute. The gravel is dumped from the track of the bed-rock tunnel to the mill platform where the larger rocks are picked out and conveyed to a waste pile, which is occasionally sluiced and yields some gold. The remainder, or softer material, is fed by hand to the mortars, which have a single discharge through screens with round holes of three sixteenths of an inch diameter. The resulting pulp flows over a table eight feet long, provided with grooves or riffles charged with quicksilver. Thence the pulp passes through "rubbers" into a concentrator, where a small proportion of the gold is saved. The mill is run by steam power and consumes three cords of wood per twenty-four hours. The working bed-rock tunnel of this mine has now attained a length of nearly one thousand nine hundred feet, from which upraises are made to the gravel as the tunnel progresses.

The force of men employed at the mine consists of:

Two engineers	$7 50 per day.
Two feeders	7 00 per day.
Three helpers	6 00 per day.
One foreman	4 00 per day.
One blacksmith	3 50 per day.
Thirty-one miners and car men	93 00 per day.
Total	$121 00 per day.

The mine, since April 14, 1880, has been yielding at about the same rate as up to that date.

Three miles west of Bath brings us into the vicinity of Forest Hill, a locality distinguished for the large product of its drift mines in the early day, the quantity of gold extracted from some of the claims here having been as large as was ever taken from a like area in any other part of California, or, perhaps, anywhere else in the world. The value of the gold gathered by a few of these companies was as follows: From the Independence, four hundred and fifty thousand dollars; New Jersey, eight hundred and fifty thousand dollars; Deidesheimer, six hundred and fifty thousand dollars; Jenny Lind, one million one hundred thousand dollars (mostly from the upper and poorer red gravel); Dardanelles, two million dollars (taken out of the lower stratum of rich blue gravel); the area of ground worked over in these several claims not having exceeded eight or ten acres.

Besides the above companies, some half dozen others took out about two hundred and fifty thousand dollars each, while a dozen or more realized from fifty thousand dollars to two hundred thousand dollars each. Some forty thousand dollars, taken from the Gore claim, was found in a depression in the bedrock about three hundred and eighty feet square; the Independence yielded ten thousand dollars from an area twenty feet square. With the exception of the Dardanelles, none of these claims were large, their frontage ranging from one hundred up to six hundred feet, the Dardanelles company alone owning as much as a thousand. Save in the case of the Dardanelles, but little work has been done on any of these claims for many years past, the big results above alluded to having been obtained over twenty years ago. They are all on the front channel, and having exhausted them of their pay gravel the owners have, in only a few instances, undertaken to open up the ground further back. The Mountain company is the only one that has ever reached and extracted any gravel from the back or middle channel. This company owns two thousand three hundred feet on the main channel, and one thousand seven hundred feet on a branch channel, and has taken out considerable money.

THE DARDANELLES COMPANY.

The possessions of this company are situate about one mile below and to the southwest of the town of Forest Hill. They are very extensive, consisting of several hundred acres of auriferous gravel lands, both hydraulic and drift, the most of which is patented. After a portion of this ground had yielded so well worked by drifting, hydraulic mining was carried on here for a number of years, the property now being worked with moderate success by both methods. Owing to the rather limited supply of water at command, these deposits will probably be found to pay better worked by the drift than by the hydraulic plan. The ground has lately been thoroughly opened up by means of a long bedrock tunnel, and is now reported to be in good shape for extensive drift operations.

Several drift companies are operating on the channel below the Dardanelles, but none of them have as yet reached any very gratifying results, though they have been at work off and on for a long time, and have in the aggregate spent a good deal of money. Other drift companies than those already noticed have also been at work elsewhere on this divide without achieving any great success, though the prospects of some of them are said to be good, and in a few cases, are no doubt of a very encouraging kind.

Drift mining, though prosecuted to some extent along the main gold belt further south than this divide, did not, if we except a few locations worked at an early period, prove to be a prosperous industry.

From fifteen to twenty-five years ago, many long and expensive tunnels were driven under the Stanislaus Table Mountain for the purpose of working the dead river buried under that basaltic flow. But the results reached were so generally disappointing as to discourage the further exploitation of this class of deposits, nearly all the companies who embarked in the business having expended more money, value of labor included, than they ever got back. Save only in a few instances, the efforts directed to the exploitation of these table mountains have in like manner been but poorly repaid.

EL DORADO COUNTY.

In times past, a great deal of drift mining was done in the locality known as Coon Hollow, near the town of Placerville, El Dorado County; the deposits, which lay under a heavy body of cement, having been reached and worked through both shafts and tunnels. In spots, this ground paid remarkably well, though most of it yielded only what were considered fair miners' wages at that day. Of late years, but little drift mining has been carried on in El Dorado or any of the counties to the south of it.

CALAVERAS COUNTY.

Quarter of a century ago, San Andreas, Mokelumne Hill, Douglass Flat, Murphy's, and Vallecito were all populous and lively drift camps in Calaveras County, the majority of the claim owners there having realized large wages, but there is not probably one dollar taken out in those places now, where formerly there was a hundred, this style of mining being at present nearly an extinct industry in Calaveras County.

CRUSHING THE INDURATED GRAVEL—MILLING OPERATIONS OF THE INDIANA HILL COMPANY.

From ten to fifteen years ago many stamp mills were employed for crushing the cemented gravel taken from the drift mines. Afterwards the use of these mills was, in good part, discontinued; the plan of disintegrating this stuff through long exposure to the atmosphere, after breaking it up with powder, having been generally adopted. Of late years recourse to the stamps is again coming into practice, and it is more than likely that the number of these mills will be considerably increased in the near future.

As the Indiana Hill Company have been running one of these mills for a long time on their mine, near Gold Run, Placer County, the history of this enterprise may be cited as fairly illustrating this method of disposing of the gravel too hard to be readily disintegrated by the action of water alone.

This company commenced operations with their eight-stamp mill in 1872, and have kept running pretty steadily ever since. This mill is driven by water brought in by the company's ditch and delivered under a pressure of eighty feet on a ten foot hurdy-gurdy wheel, and has capacity to crush about forty-five car loads per day on an average, the car load here containing nineteen and one half cubic feet and weighing sixteen hundred pounds.

The average yield and the cost of mining and milling the gravel here has been about as follows:

Yield.	
Per carload	$3 77
Per ton of 2,000 pounds	4 71
Per cubic yard	5 29
Cost.	
Per carload	$2 03
Per ton of 2,000 pounds	2 54
Per cubic yard	2 90
Profit.	
Per carload	$1 74
Per cubic yard	2 39

The gross annual production made by this company has ranged from forty thousand dollars to sixty thousand dollars, the average having been about fifty thousand dollars, of which sixty per cent. has been net profit. This company employs, on an average, twenty-five men; wages two dollars and a half per day (formerly three dollars). The stratum of gravel taken out here varies from seven to eight feet in thickness, including a foot or more of bedrock, the latter a soft green slate.

YIELD OF DRIFT GRAVEL PER CARLOAD, CUBIC YARD, AND OTHER METHODS OF MEASUREMENT.

By the term carload, as used in the following remarks, is meant sixteen cubic feet of gravel, weighing about one thousand seven hundred pounds, this being the quantity contained in the car boxes most in use, although a few companies employ cars of much greater capacity. This is gravel after it has been broken down, one yard of the material standing in place being equal in bulk to nearly two after it has been drifted out.

While the beds of the pliocene channels have, so far as explored, shown themselves to be much richer than the beds of the modern rivers, they have, like the latter, proved to be spotted; long and barren stretches alternating with others of great fertility. It is the case, however, that the continuity of the auriferous sections suffers less interruption in these ancient rivers than in those of the present day.

The value of the gravel extracted from the drift mines of California fluctuates over a broad range, varying from one to thirty dollars per carload. Confined within narrower limits, the value of this material may be said to vary from one dollar to four dollars per carload, the average being perhaps about two dollars. We append values of gravel from a number of drift localities, taken at random and widely separated.

The gravel taken from under the Stanislaus Table Mountain paid at the rate of three dollars and seventy-five cents per carload, being of somewhat lower grade than most of that taken from under this class of formations. The gravel extracted from the Virginia claim, at Howland Flat, Sierra County, has for some time past averaged five dollars per carload, being five times as much as the average of that taken from Squire's ground in the same neighborhood. The North Fork claim, near Forest City, pays five dollars, and the Bonanza, at Howland Flat, fifteen dollars per carload, quite steadily. Four drift companies—the Down East, Union, Pittsburg, and Hawkeye—about Potosi and Howland Flat, extracted from three hundred and ninety-four thousand one hundred and sixty-five cubic yards of gravel, two million two hundred and forty-six thousand six hundred and forty dollars, being at the rate of five dollars and seventy cents per cubic yard. The stratum of gravel removed here was four and one half feet thick; cost of extraction and washing having amounted to a fraction less than one half the total value realized. A late strike in the Dardanelles shows a body of gravel worth from five to ten dollars per carload; average about seven dollars; the Weske ground, lying a few miles higher up the Forest Hill divide, having for a number of years averaged nearly as much. The Damascus Company, on the same divide, mill their cemented gravel, which yields about four dollars and eighty cents per ton.

The Wide West, Swamp Angel, and several other claims, situate on the Steep Hollow divide, Nevada County, have for a series of years taken out about fifty ounces of gold to every five hundred carloads of gravel, being at the rate of two dollars per carload. The drift mines along Trinity River have yielded three dollars and fifty cents per carload, but the quantity of gravel here taken out has been comparatively small, the gravel channels in that section of the State being generally narrow, and the pay stratum shallow.

The value of the drift gravel worked throughout the State has ranged from twenty to eighty thousand dollars per acre, and from two to three hundred dollars per linear foot. The gravel extracted from the group of claims located near Forest Hill, and worked out prior to 1860, yielded at the rate of nearly half a million dollars per acre.

From the foregoing it will be seen that both hydraulic and drift, like every other branch of mining, are beset with many obstacles and difficulties, some being incidental and exceptional, while others may be considered inherent to, and inseparable from, the business. But with all these drawbacks, this class of deposits open to the local capitalist a tolerably good field for the investment of money, especially if the investor be familiar with these methods of mining, and is able to supervise or give to the business a good share of his personal attention. In these, above every other kind of mining, it is important that preliminary proceedings be conducted with care, while subesquent operations must be watched with a vigilant eye, the liability to mistake and the sources of loss being here very great. The auriferous gravel requiring to be worked by these methods is so abundant in California that it will probably be mined with profit for centuries to come. But to insure such result, the closest economy will have to be practiced, all avenues of waste being closed as nearly as possible.

ON THE MILLING OF GOLD QUARTZ.

By MELVILLE ATTWOOD, F. G. S.

ON THE MILLING OF GOLD QUARTZ.

Henry G. Hanks, State Mineralogist:

Dear Sir: My last paper to the State Geological Society on "The Milling of Gold Quartz," wherein I tried to describe the process of simple amalgamation of the raw pyritic matter in wooden barrels, appears, from the great number of letters that I have received respecting it, after its publication in the Mining and Scientific Press, to have attracted considerable attention, and has, therefore, encouraged me to resume the subject, but this time as a contribution to the State Mining Bureau; you having kindly offered to allow the specimens accompanying this paper, and intended to illustrate what I have stated, to remain for a short time at the rooms of the Mining Bureau, to give those who feel interested in the matter a chance of examining them. You have also promised to put some very important and interesting specimens from your private collection with them.

I can only now repeat what I have stated on a former occasion, that at the present time I think scarcely anything can be of greater importance to the mining interests of this State, than a simple and cheap mode of extracting the gold from low grade veinstone, and the determination of the true condition of the ores associated with it.

The "free gold," as it is called, can easily be saved; indeed, the language of the old mill-man, "only give it a chance and it will take care of itself," is very true, particularly so when met with, as it is in some of the Bodie veins, carrying scarcely any pyritic matter. The difficulty in the concentration of the sulphurets (I use the California term, which, as I stated before, was, I think, first applied in Nevada County, in 1859, to the pyritic matter associated with the quartz in the gold-bearing veins of this State), appears now to be, in a great measure, overcome by the use of the "Frue concentrator," which, with comparatively little attention, and at one operation, makes very clean work. I have served a very long apprenticeship in the "dressing" of different kinds of ores, but in all my experience never remember any machine which pleased me better than the "Frue." The rubber surface of the revolving cloth appears to greatly assist the operation.

The question of concentration being now so far solved, it renders it desirable, indeed necessary, for isolated mills to have some cheap and easy mode, which they can use at their own works, to extract the gold from the concentrations.

TREATING PYRITES FOR THE EXTRACTION OF ITS GOLD.

The following is a copy of a paper on "Iron Pyrites," read before the Royal Society of New South Wales, in 1874, by J. Latta, Esq., which contains much valuable information:

Mr. President and Gentlemen: At the request of some of the members of the Royal Society, I have ventured to occupy part of your time this evening in describing the method of treating pyrites for the extraction of its gold, as carried out by the Port Phillips Company, at Clunes.

In 1861, I was engaged by that company as their chemist and assayer, with special instructions to devise, if possible, a process for profitably extracting the gold from their pyrites, which was then but little better than a waste product. Except processes inapplicable to our circumstances, such as smelting, etc., the only known means for extracting gold from such mineral was that practiced in South America and the United States—"of exposing the auriferous sulphides to the action of air and moisture for a year or so, whereby a portion of the mineral became oxidized, liberating the gold previously inclosed by the sulphides; the mineral was then passed through the stamping battery with quartz, and whatever portion of the sulphides remained undecomposed was retained, as well as the then rude machinery for that purpose admitted, to undergo another term of oxidation, and so on whilst any remained." I scarcely need to point out how extravagantly wasteful of time and gold such a process must have been. Yet, even at the present time, this process is occasionally practiced in Victoria. At some claims the blanketings—that is, the pyritous sand, with a little free gold caught upon the blankets—are, after a time, again put through the batteries with the quartz, for the purpose of extracting its gold. Any one practically acquainted with the treatment of mineral containing fine gold by the battery process, will at once recognize the impossibility of retaining a fair proportion of such minutely divided gold as oxidized pyrites affords; by far the larger portion would be held in suspension by the water, and be carried away by it through all the appliances devised for its retention. In addition to the difficulty of retention arising from the fine state of division which gold so obtained possesses, most of these particles would be coated with iron oxide, and other products of the decomposed mineral, thus offering another hindrance to its chance of amalgamating with the mercury. This latter difficulty deserves careful consideration, where fine gold has to be dealt with, as from its fineness it escapes the scrubbing which the larger grains receive from contact with the quartz whilst crushing, whereby their surfaces are cleaned, and thus rendered extremely sensitive to the influence of mercury placed for their detention. In reference to the condition of the gold in pyrites, it has come to be pretty generally admitted that "nearly, if not quite all, the gold exists in the metallic state."

This quite agrees with the results of some experiments carried out by myself in conjunction with Mr. Daintree, late of the Victoria geological staff. Our researches ended in obtaining but the barest possible evidence of gold existing in a mineralized state in pyrites.

As a matter bearing somewhat in support of this result, and whilst engaged in these investigations, I had the good fortune to come across some fine specimens of cubical pyrites, which, upon examination with a pocket lens, seemed to indicate the presence of gold; upon transferring them to a good microscope, gold was distinctly seen upon the planes of cleavage, and upon dissecting the crystals, every cleavage face was found distinctly gilded. Now, from the fact that the presence of gold could only be determined by the aid of a good microscope, and that only as a fine gilding, some notion may be formed of the excessively fine state of its division, and how unsatisfactory would be the task of separating such liberated films from water in motion.

Guided by these considerations, it became evident that any attempt to mechanically separate gold from pyrite—unless aided by the previous decomposition of its enveloping sulphides—must prove ineffective from the impossibility of reducing it to its ultimate atoms, for so long as a cluster of sulphide atoms remains unbroken, they might reasonably be imagined to inclose those of gold. Again, it was equally clear that when such gold was liberated from its envelop, water concentration alone was inapplicable. To test the correctness of these conclusions, each of them was made the subject of rigid experiment on an extended scale before receiving them as fundamental truths to guide us in determining the best method suitable to our requirements. Two parcels of pyrites, of twenty tons each—one roasted, the other unroasted—were ground in one of the best arastras, known, with mercury; a constant stream of water flowing through to carry off the finely ground sand, which was then carried through mercury boxes and over blankets. Each parcel received the same amount of grinding and treatment in every detail. The result was as follows:

Twenty tons raw sand containing 3 oz. 6 dwts. per ton:

Gold obtained	29.21 per cent.
Gold in tailings	42.84 per cent.
Gold carried off by water	27.95 per cent.

Twenty tons roasted sand, 1 oz. 7 dwts. 10 grs. of gold per ton:

Gold obtained	51.57 per cent.
Gold in tailings	27.31 per cent.
Gold carried off by water	21.22 per cent.

Here it will be observed that, with the raw sand, only a small portion of the gold was obtained—a very much larger was left in the tailings, although finely ground, and a large proportion was carried off with the water as slime. With the roasted mineral, more than half the gold was obtained; the tailings were much poorer than those from the raw sand, but still very rich, and a large quantity was carried off by the water.

After carefully considering the merits of the various methods suggested for extracting gold from pyrites, our first problem to solve was how to best destroy the enveloping sulphides and arsenides so as to get rid of the deleterious action of these minerals upon the mercury used for amalgamating and detaining the liberated gold; and secondly, the best method of extracting the gold from the decomposed pyrites. After a number of experiments on a large scale, it was decided to effect the decomposition of the pyrites by a roasting process. To effect this economically, I dévised, and in conjunction with Mr. H. A. Thompson, patented, in 1862, the inclined roasting furnace, which is now used in many places throughout the Colonies. It consists of an inclined roasting hearth, usually about thirty feet long by five feet wide; the fire hole for heating the hearth on the lower end of it, and is separated from it by the fire bridge; between the latter and the hearth is a channel for conveying into the store pit the sand when roasted. In the footwall of the furnace are six tubes, from one and a half to two inches diameter, for supplying heated air to the roasting sulphides; scarcely any air is admitted through the fire bars, the gaseous vapors from the fuel being completely burned by the great excess of air passing over the fire for oxydizing the pyrites. Along each side of the furnace are five working doors, for the workmen to turn and rake down the mineral. Above the upper end of the furnace a large hopper is constructed, capable of holding twenty-four hours' supply of sand; in the floor of this hopper is a trap for supplying mineral to the hearth. The hopper is filled by trucks communicating with the puddles by a tramway to the stamp house. The whole of the furnace is carefully braced with vertical, longitudinal, and transverse ties. The present furnace has been working about ten years, and with fair treatment, will last many years more. In working this furnace, the whole of the hearth is covered with pyrites to the depth of between two and three inches, kept at a gentle red heat, with frequent stirring, until the mineral nearest the fire, and about six feet beyond it, is found to no longer give off sulphur fumes. An experienced workman can determine when this condition has been obtained by its appearance in the furnace. It is then raked into the discharge channel and the mineral lying upon the hearth immediately above that removed, is brought into its place; again, that still further up is brought a stage lower, until the whole has been shifted, when the vacant place at the upper part is refilled from the hopper. The sulphurous and arsenical vapors, together with the products of combustion, and dust from the pyrites, pass into a tunnel between two hundred and three hundred feet long, four feet high, and three feet wide, carried up the side of a hill, terminating in a chimney thirty feet high. Nearly all the sand and dust carried over by the draft is deposited within forty feet of the furnace, and is periodically removed for retreatment, as it contains a notable quantity of gold; beyond forty feet the sand is worthless. From the size of the tunnel the vapors move slowly onward, and have, consequently, time to deposit any heavy particles; continuing their course, the vapors pass through six cellular brick screens, down which a powerful spray of water passes; here they get cooled and scrubbed, the sulphurous and sulphuric acids dissolved out, whilst the arsenious acid is deposited on the floor of the tunnel, scarcely anything escaping from the chimney but the foul vapors. Some alarm was felt by the Town Council lest any arsenical vapors should escape and prove injurious to the inhabitants, as the works were close upon the township, and they placed the matter in the hands of Mr. Johnson, the Government Analytical Chemist, for investigation, who reported as follows: "I drew five gallons of the vapors from the chimney of the roasting furnace, and by the application of one of the most delicate tests known to science, viz: Reinck's test, discovered but the merest trace of arsenic." I may remark, that when this investigation took place we were condensing over two tons of arsenic per month in the tunnel. I have dwelt somewhat lengthily upon this part of my subject as I am desirous to show that, with due precautions, such operations can be safely carried on in the neighborhood of habitations.

In carrying out the roasting operations the work is divided into three shifts of eight hours each, one man being able to attend a furnace, and finally to cover up the hot sand discharged with damp sand and spray it with water. This quenching was found to be a matter of some importance, as the quartz sand—always found with the pyrites—is thereby broken up and rendered friable, by which the after process of grinding is greatly facilitated. The quantity of sand which a furnace of the above mentioned size can treat, will average four tons per twenty-four hours, with a consumption of three tenths of a cord of wood per ton. Having determined upon a mechanical process for extracting the gold from the roasting mineral, it became necessay to discover the best condition for accomplishing it. In this, also, we were greatly assisted by the knowledge gained of the physical condition of the gold in pyrites. Consequently, after our earlier experiments already mentioned, we carefully avoided a current of water, and ground with mercury without an overflow until it was considered the gold had become amalgamated. By cautiously varying the experiments, and ascertaining the proportion of gold obtained in each case, we were led up to the present method of working. From the results of a great number of experiments, it was shown that the quantity of water used in the grinding process was a matter of considerable importance, the success of the operation to a great extent depending upon the sand being in a damp condition only. By this means the mercury becomes thoroughly diffused, and every grain of sand has a particle of mercury in contact with it; consequently there is afforded abundant opportunity for the gold to amalgamate. On the other hand, if sufficient water has been used to convert the mass into a semi-fluid state, the mercury remained at the bottom of the mill, the surface only being in contact with the sand; consequently the opportunity for amalgamation was considerably lessened, and the quantity of gold extracted very much less than when working damp sand only. As the result of these experiments, the following process has been adopted: The sand, after being roasted, is ground—only moderately damp—with an equal weight of mercury for three quarters of an hour, under the rollers of an ordinary Chilean mill; water is then allowed to flow into the basin, the mill still revolving, until nearly all the finely ground sand has been carried off in the overflow to the concentrator; the mill is then stopped, the water drained off from the underground sand and mercury, again started, and recharged with fresh sand, and so on until it is necessary to clear out the amalgam—generally once a week, depending upon the richness of the mineral treated. The finely ground sand passed into the concentrator is kept slowly stirred for a quarter of an hour, to keep the sand in suspension in the water, and allow the mercury and any amalgam which might have been carried over from the mill to gravitate through it. The water with its sand is then slowly run through a smaller concentrator, to retain any valuable particles which might have escaped the first, and is then considered sufficiently impoverished to be allowed to run away.

The quantity of roasted mineral the Company treat by this process, when working, averages eighteen tons per week—the duty of two mills worked in eight-hour shifts, one man attending them, alternately changing and discharging.

The average proportion of gold extracted during the last year, from two hundred and ninety-four tons of pyrites, amount to 95.19 per cent. of the assays, the sand averaging four and a half ounces of gold per ton. Some of the parcels returned as high as ninety-eight per cent. during that period. The cost of extraction amounted to two pounds two shillings four pence per ton, without estimating wear and interest on capital. The above charge is rather high, as fuel during that period was unusally dear, and the furnace being but four feet wide, instead of five feet, increased the labor cost, as less work is done at the same cost than would be incurred in working a larger furnace. Another element in the cost is the mercury which is lost, amounting to one pound and thirteen ounces per ton—a large proportion of which, I think, might be saved by improved appliances for that purpose, together with the gold contained in it. The immediate cause of this loss of mercury is the severe trituration to which it is subjected with the sand. This was found indispensable, for whenever, through oversight or experiment, a less degree of trituration was applied than that now used, or the sand ground too wet, the return of gold was invariably diminished by several per cent.

In carrying out these operations, I found that a large proportion of galena in the mineral seriously interfered with the extraction of the gold, but a small proportion of the sulphides of copper, zinc, or lead produced no appreciable effect.

Taking the process as it stands, we have been unable to find one that would at less cost extract the same proportion of gold, or could be safely trusted in unskilled hands with only occasional supervision.

Mr. Thompson also read the following:

Returns of pyrites treated at the Port Phillip Company's works, Clunes, since October, 1866.

YEAR.	MINERALS TREATED.		GOLD PER TON PER ASSAY.			TOTAL GOLD OBTAINED.			GOLD EXTRACTED PER TON.			Percentage Extracted.
	Tons.	Cwt.	Ozs.	Dwts.	Grs.	Ozs.	Dwts.	Grs.	Ozs.	Dwts.	Grs.	
1867	215	17	4	16	6.93	960	13	------	4	9	------	92.43
1868	366	9	3	18	6.56	1,322	13	------	3	12	4	91.71
1869	401	11	4	1	19.15	1,515	11	------	3	15	11.60	92.28
1870	431	9	3	11	4.34	1,370	4	------	3	3	12.60	89.24
1871	561	2	4	7	10.99	2,290	1	------	4	1	15.20	93.34
1872	368	6	5	18	19.36	2,031	9	------	5	11	22.56	94.22
1873	394	------	4	10	16.30	1,268	17	12	4	6	7.63	95.19

The results obtained by Mr. Latta appear to have been exceedingly close and satisfactory, though rather costly—about ten dollars a ton—which, I think, could have been much lessened had the stuff been reduced finer, and the concentration been carried a little further, so as to have freed the pyrites from the excess of gangue or quartz sand previous to calcination.

It is now generally admitted by metallurgists of any note, that the gold in pyrites exists in a metallic state, and it is with no little pleasure that I am enabled to practically corroborate the statements of Mr. Latta on this subject, having procured for your inspection a number of crystals, of auriferous pyrites, obtained from different parts of this State. They are mounted on glass slides for microscopic examination, as with a common lens the presence of the gold can hardly be detected; but with a good microscope, using an inch or half inch objective, it will be found that the faces of some of the crystals are, in places, most finely and beautifully gilded, and that here and there are seen little specks or drops of gold partially imbedded in the pyrite. The mill-man, after looking at these specimens, will not be surprised at the loss sustained in the wet stamping of auriferous pyrites.

SAMPLING AND ASSAYING GOLD QUARTZ.

In Phillip's Metallurgy, pages 166 and 167, very good directions are given for sampling and assaying gold quartz. For assaying, he says: "The most accurate results are obtained by carefully washing a four-pound sample in the batea. After having in this way concentrated the gold in about an ounce of sand and pyrites, this residue may be either subjected to assay, or the sulphides dissolved by nitric acid, and the gold extracted by almagamation with mercury, which is subsequently volatilized, and the gold weighed. In either case, calculations are made on the four-pound sample, and when the residue has been subjected to fusion, very accurate results are obtained."

BARREL AMALGAMATION.

During the time I was engaged in gold mining in Brazil, I stayed for some time at the St. John del Rey mine, and there witnessed the barrel amalgamation which I described in my last paper to the State Geological Society, and which is reproduced here:

Their process of amalgamation is nearly perfect, but the stamping and concentration very defective, the stamps doing but little duty—only one and one fourth tons per head during the twenty-four hours; their plan of concentration being principally what is called "straking," consisting of a number of fixed inclined trays thirty feet in length and eighteen inches wide, with a fall of one inch to the foot. The trays are covered for the first sixteen feet with bullocks' skins tanned with the hair on them, and in lengths of two feet two inches; below these are series of blankets or baize cloths of the same length. The deposit of sulphurets on the first three skins contains nearly all the gold, and amounts to about 0.42 of a cubic foot per ton of veinstone stamped. It contains about thirty ounces of gold per ton, all of which, with the exception of one ounce, is in a free state; the ounce of gold being mechanically mixed with the coarser grains of pyrites.

It is estimated that in stamping and straking, ten per cent. of the total amount of the gold is carried off in suspension by the water.

Their loss in amalgamation is comparatively trifling, as far as I can gather from their numerous reports, and will average less than four per cent.; the loss of mercury is 0.45 ounces per cubic foot of sulphurets amalgamated. The apparatus employed for amalgamation of the sulphurets consists of wooden barrels four feet in length and two feet five inches in diameter, having a capacity of twenty cubic feet. The charge of sulphurets for each barrel is one ton and a half, free from decomposition, and sixty pounds of mercury. There is also a sufficient amount of clean water at the same time introduced to give the slimes the necessary degree of fluidity to enable the globules of quicksilver formed to become properly incorporated, without allowing them to become sufficiently mobile to admit of the settling of the mercury and amalgam at the bottom. The barrels, when charged, are allowed to rotate from twenty to thirty hours, making eighteen revolutions per minute, in accordance with the state of the atmosphere.

The contents of the barrels are afterwards washed in an apparatus called a "saxe," which is used to separate the gold amalgam from the refuse. In this country it might be perhaps better to employ separators the same as those used in the different pan mills.

In their report of 1880, the result of their trials of the Comstock pan system was anything but satisfactory; indeed, in the milling for gold that system appears to be too costly for low grade ores, and not fit for the rich. It is better calculated for the treatment of veinstone which contains in the ton from five to ten ounces of silver, and that in a suitable mineralized condition, as chlorides, etc.

The attempts to grind the sulphurets when they contain upwards of fifty per cent. of pyritic matter, and to amalgamate the mechanically combined gold inclosed in the particles of pyrites, at the same time and in the same pan, has not been attended with success from the earliest attempts, some of which I witnessed in Brazil in 1832, which was then made in an apparatus being a modification of the Hungarian bowl. The St. John del Rey sulphurets, when ready for the barrel, contain about ninety-five per cent. of pyritic matter, and are reduced so fine that ninety per cent of it will pass through a sieve having one hundred holes to the linear inch.

What I have tried of the California sulphurets the pyritic matter varies from seventy per cent. to ninety per cent., and about seventy-five per cent. of it will pass through a sieve of one hundred holes to the linear inch.

The following analyses were made by John A. Phillips, F. G. S., and published in his Metallurgy of Gold and Silver. I lately received a letter from him, wherein he tells me he is going to publish another work on gold:

Analyses of auriferous California pyrites concentrated from tailings by John A. Phillips.

	From Grass Valley.	From near Sonoma.	North Star, Grass Valley.
Sulphur	46.700	37.250	43.720
Arsenic	.310	8.490	1.360
Iron	41.650	36.540	39.250
Copper	trace.	trace.	.220
Lead	trace.	.400	trace.
Gold	.037	.302	.026
Silver	.036	Not determined.	.012
Cobalt	.036		.150
Silica	10.970	17.150	14.230
Totals	99.703	100.162	98.968

Per ton of 20 cwt.

	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.	Oz.	Dwt.	Gr.
Gold	12	2	0	93	13	0	8	10	0
Silver	11	16	0	--	--	--	3	18	0

By careful analysis their concentrations differ but little from those of some of the mines near Sonora, Tuolumne County, California, the amount of arsenic varying from one to ten per cent., though in the upper part of the St. John del Rey mine it did not contain so much arsenic as the following analysis, made by John A. Phillips in 1847, shows:

Analysis of uncrushed ores from the St. John del Rey mines, made by J. Arthur Phillips, in 1847:

Silica	16.87
Carbonate magnesia	12.17
Carbonate lime	3.01
Sulphur (iron pyrites)	16.78
Iron (iron pyrites)	14.65
Peroxide of iron	32.84
Peroxide of manganese	3.63
Arsenic and gold	Traces.
	99.94

N. B.—Gold per ton equal 1 oz. 2 dwt. 20 gr.

The reason I have said so much about these mines, and called your attention so frequently to them, is from the fact of their successful treatment of such a difficult veinstone for so many years. To properly understand the magnitude of the work, suppose we estimate the yield of the veinstone in California, from all the mines in pyritic matter, to be, say, five per cent. of all that is worked (which is rather high), it will hardly equal that treated daily at the St. John del Rey works.

The results of years of experience in working such a mine ought to be interesting, even if it were not exceedingly valuable, as it really is; yet there are not wanting those who object to any information obtained from the reports of such as the St. John del Rey company, on the (not very wise) grounds of the mine being worked in Brazil, and the reports printed and published in London; and, may be worse than all, that the dividends are, and have been for the last forty years, paid there. In the

MILLING OF CALIFORNIA GOLD QUARTZ,

I would advise, for low grade rock, the stamping of it as coarse as such a machine as the "Frue" or other improved concentrator can treat to advantage. The size of the aperture in the screens should gradually increase, and be the largest in the upper part, which would, in a great measure, prevent what is termed "dead stamping," and, at the same time, add greatly to the duty of the stamps. Screens having twelve holes to the linear inch in the bottom and ten in the upper part, are not too coarse for low grade rock. As a stamp-head weighing eight hundred weight will then, on an average, reduce four tons in the twenty-four hours, and those of six hundred weight about three tons, and any trifling loss of free gold will amply be made up by what is saved in the sulphurets—*so that a "ten-stamp mill," with heads weighing eight hundred weight, can be made to work to advantage forty tons of rock per day.* The fineness of the stamping, however, is in part regulated by the position of the screen; that is, their horizontal distance from the stamp-head and the vertical height of the bottom of the screen above the level of the die. For example, the finest work is done by splash-stamping; that is, without using any screens, and allowing the pulp to be discharged over the front side of the mortar, which is purposely made lower than the back or feed part of the mortar.

The Port Phillip Company, in Australia, I believe use them with ten holes to the linear inch. Steel wire cloth is the best and will, I am told, last better than any other.

Some years ago, in a communication to the State Geological Society on the subject, I recommended fine stamping for low grade rock containing a large proportion of sulphurets; but recent improvements in concentrators, and a closer examination of the condition of the gold in the iron pyrites, of which I find so large a proportion is in thin films, and which, with a rapid flow of water, would be carried away and a greater part of it lost, have altered my opinion on this point.

It is not generally known, but nevertheless, from numerous and very careful tests, it is proved that in fine stamping, when the speed of the stamps is above seventy-five blows per minute, that the loss of gold, when blankets or rawhides are used, is much greater than at a speed of fifty blows per minute; though I am not aware that any tests have been made when the amalgamation was done in the battery. The system of

AMALGAMATION IN THE BATTERIES,

However, I have always considered a mistake, and as entailing a great loss of gold, particularly so when the rock contains a large proportion of sulphurets; besides, if precautions are not taken, a low degree of temperature will render the amalgamated silver plates nearly useless. To understand this correctly, let the mill man put two or three barrowfuls of rock very rich in sulphurets through the stamps, and then watch the effect on the amalgamated plate, and at the same time collect some of the pulp after passing over the plates and have it carefully tested, and he will then better understand why I prefer the blanket system.

Professor W. W. Smyth, in one of his lectures on gold, with respect to stamping, says: "Take a large hammer and gently crack a nut with it, and you have an illustration of what a stamp ought to do; it ought, if possible, to crack the enveloping shell of stone, and set free the kernel of metallic mineral unbroken."

Or, for instance, take a piece of veinstone from the Bodie district—the same as marked No. 26—one half of it pound very fine, using a grinding action with the pestle, then wash out the gold in a batea, or horn spoon, and you will find that a large proportion of the gold will float away, in spite of every care, even using ammonia to destroy the grease on the ends of the fingers.

Then take the other half, pound it very coarsely, and in washing out the gold you will see very little float, and two or three turns of the batea will bring all the gold into the center.

In the blanket system, where improved concentrators are used, after the pulp has passed over the blankets, only two lengths of trays of about four feet each, and two sets to each five stamps are required. They should be so arranged that the inclination can be altered, say from three degrees to five degrees, to suit the stuff being treated.

The trays should be about sixteen inches wide, and the fall from the battery box to the head tray the same as from one tray to another, about four inches, with a board placed across the end that the fall of the water or pulp will be so broken as to strike the blanket in the tray below nearly at right angles. The blankets should be in three feet lengths, and made of coarse wool with a long nap. The double sets of trays are for the convenience of changing and washing the blankets. The blanket washings can be passed through a simple machine like that described in Phillips' Metallurgy (see page 185), and the tailings from it ground with the coarse concentrations in a Chilean mill.

It is not so much the length of the blankets that separates the gold from the gangue, but the fall, or jump, on them.

Where the mill has a limited supply of water, and they do not like to go to the expense of a number of concentrators, a coarse concentrator may be made with a "Tye Buddle," the plans and the descriptions for the use of which will be found in "Phillips' Metallurgy of Gold and Silver," page 187.

The concentrations from the "Tye" can be passed over the "Frue," one of which would then be sufficient for a large mill; though I am not prepared to say by such means they can work as closely as by using the "Frue" alone.

In case the mill is not situated at a very great altitude, where the frost might interfere with this working, amalgamated plates, in three feet lengths and two feet deep, on a fixed frame at an angle of about three degrees, to which a slow lateral movement backward and forward of one foot, together with a slight shake, is given, in the same direction, with a sprinkling of clean water from a perforated pipe falling on the upper part above where the pulp strikes, might be placed with advantage between the blankets and concentrators.

The concentrations should be sifted through a sieve having eighty holes to the linear inch, and any particles that were not fine enough should be ground in a Chilean mill, the same as described by Mr. Latta, but without using the mercury, and afterwards charged into wooden barrels for amalgamation; but, before charging, the sulphurets should be soaked in water, to free them from all decomposition. I feel confident that larger results will be obtained by thus treating the raw ore than if it was roasted.

The great difference between a wooden surface and a metal one in amalgamation can easily be shown by washing out, say, about one pennyweight of Bodie or Grass Valley gold in a batea and then adding, with a dropping bottle, just sufficient mercury for it to amalgamate with—too much or too little will lengthen the result; but if the proper quantity be used, by rubbing it with the finger in the center of the bowl it will amalgamate rapidly in less than a minute. Try the same experiment with an iron pan, and you will find how much longer it takes to get the same result. I would strongly recommend any mine adventurer, before erecting any quartz mill, or adopting any particular process, to have some twenty or thirty tons of the rock or veinstone stamped, and to save, during that operation, a fair sample of the battery pulp from it, which should be carefully concentrated in a batea, or any other utensil used for washing on a small scale. The condition and quantity of the gold, and other ores and minerals, should be tested and examined. The percentage of the sulphurets can also be roughly estimated at the same time, and all afterwards compared with the gross results from stamping.

TEST FOR TELLURIUM.

Mr. Edward Booth, analytical chemist, has kindly furnished me with directions for making a simple test for tellurium, in case telluric gold is suspected to be mixed with the sulphurets. It is as follows:

> Place in a test tube or other vessel capable of resisting the action of acids, a small amount of the suspected material, which has been separated as thoroughly as possible from the accompanying gangue, add enough sulphuric acid to well cover the sample, and heat to boiling; if tellurium is present the liquid becomes colored a clear purplish red.

I have only found, as yet, telluric gold in two mines in Nevada County—one near Grass Valley, and the other, the Murchie mine, near Nevada City.

In my private collection I found a specimen marked "Meadow Lake Ore;" I do not recollect who gave it to me, but it contains both gold and telluric gold.

REBELLIOUS GOLD ORES.

A great deal has been written and said about the so-called rebellious gold ores of the Meadow Lake District, and what the different *process-men* were going to do with them, but I never remember having heard of any careful analysis being made, either of the veinstone or the concentrations. I would therefore respectfully suggest to those who have any samples of the Meadow Lake ores to donate them to the State Mining Bureau, as the examination and determination of them would be of the greatest importance to the mining interests of the State. The mines were discovered, I think, in 1862, and in 1865 and 1866 eight quartz mills were erected; a large town built, estimated to contain five thousand inhabitants. Now the place is quite deserted.

In the published reports of the geological survey, 1864, by Professor Whitney, no mention is made of the mines or district, so that little could have been known about them at that time.

THE PAN SYSTEM.

I can only now add, that had I years ago acted upon what I now suggest to others, I would have saved large sums of money for my partners and myself. For instance, what is the difference between the gold and sulphurets in the Mammoth lode, Mono County, and in the Sierra Buttes lode? Is not the gold in the latter much more difficult to save, and would not the Comstock soda, salt, and pan system, if introduced at the Sierra Buttes mine, soon close it up like the former? For my own part, I firmly believe that if the same pan system were used in the Victoria district, Australia, all the mines using it would soon cease to pay dividends; and also, if the Idaho mines, at Grass Valley, were to try it, that their dividends would soon be reduced one half.

If the correct number of tons of mercury, soda, salt, and "other chemicals," as they are called, that have been sent to the Mono County mills, were published, I am afraid it would appear to be very large.

It might be urged, that the chemicals used in the Bodie mills were for the extraction of the silver from the ores. In that case, it would be exceedingly interesting to ascertain the expense, and see if it did not, as some think, cost two dollars in coin for every one dollar in silver so obtained.

CATALOGUE OF SPECIMENS.

The following is a catalogue of the specimens which I shall place in the State Mining Bureau to illustrate this paper:

No. 1—Crystal of pyrite on a glass slide. Some of the faces are very finely and beautifully gilded; so fine indeed that it requires an inch objective to see it to advantage. From the Eureka mine, Grass Valley.

Nos. 2, 3, and 4—Gold, in little drops or specks, imbedded in the pyrites. From El Dorado County.

No. 5—A specimen of arsenical pyrites with gold. From a mine near Nevada City.

Nos. 6 and 7—Sections cut from the same, in which the gold is easily recognized.

Nos. 8 and 9—Gold, with telluric gold.

No. 10—Section cut from same.

No. 11—Gold in carbonate of lime. Eureka mine, Grass Valley.

No. 12—Gold in talcose slate. Taquarilla mine, Brazil.

No. 13—Gold in talc. Placerville.

No. 14—Gold in talc. Brazil.

Nos. 15 and 16—Gold in Iacotinga (micaceous iron). Gongo Soco mine, Brazil. The Iacotinga veins are from a few inches to many feet in width.

Nos. 17 and 18—St. John del Rey veinstone; 18 is about the average of what was milled in 1866.

No. 19—Specimen of killas from St. John del Rey mine; a rock which forms the sides of the lode, but also contains considerable pyrites.

Nos. 20, 21, and 22—Section cut from St. John del Rey veinstone for microscopic examination.

Nos. 23 and 24—Sections cut from the killas.

No. 25—Yellow dusty matter mixed with gold, taken out of one of the richest pockets ever found at Grass Valley.

No. 26—Veinstone with gold. Bodie District.

No. 27—Gold in country rock (diorite). From Nicaragua.

No. 28—Gold in quartz crystal.

No. 29—Gold in syenite.

No. 30—Section cut from No. 29.

I have cut a great number of sections from St. John del Rey veinstone, but could not detect the gold in any of them, and unless very great care is taken the batea test will hardly show any gold; notwithstanding which, on a large scale, they obtain better results from the amalgamation of the raw sulphurets than any other process I have seen tried.

THE TRIBUTE SYSTEM.

I have just received a copy of the report of the Port Phillip Company, Australia, published January 13, 1881, by which it appears the tribute system has been introduced there with great success. Too much can hardly be said in favor of such a system, as it places the hard working and intelligent miner on a much more respectable and independent footing; and though he in a measure shares the risks, but only so far as his judgment guides him, he gets the benefit of any discovery he may make. It also encourages him to study the peculiarities of the lode and inclosing rocks; besides which, by that system, all are jointly interested in the welfare of the mine. Many of the mines now idle in this State could be worked profitably under the system, particularly in the Bodie district.

In the Port Phillip report it says:

> The number of tributes has averaged about two hundred during the year, which shows no decrease when compared with the preceding year. The tribute system has been further extended by an arrangement with the tributers to drive the levels in the ground let to them, the company assisting them in driving timber and rails, and making an allowance per fathom until the yield reaches six pennyweights per ton, when no further assistance is given; the company receiving half the gold obtained, and deducting from the allowance the cost of tramming. By this means a large amount of driving is done at a comparatively small cost.

The number of tons of quartz stamped on tributers' account for the year was forty-eight thousand one hundred and eighty-four tons. The average yield of the entire quantity raised was five pennyweights five and one half grains per ton (say five dollars).

Total receipts	£32,364	14s	7d
Expenditure	26,310	10s	7d
Leaving a profit of	£6,054	4s	0d

In conclusion, so thoroughly am I convinced of the great benefits that would result to this State by a more general introduction of the tribute system in an extended form, both to the placer as well as vein mining, that I wish particularly to call your attention to it, so that, through the influence of the Bureau, the subject may be brought in a proper light before the owners of mines or claims. A fair tribute will secure the *muscle* of the working miner, who, in too many cases, understands better than the Superintendent (generally a man of business) how to conduct trials for ore, and afterwards to develop them. The *muscle* of the skilled miner is in every respect better than foreign capital.

There is no need of the hard-working miner to leave this healthy climate in search of employment, if those who own mines that are now idle would let the fact be known through the press, and at the same time offer a fair tribute for working them.

Rare Minerals Recently Found in the State.

By WILLIAM P. BLAKE.

Rare Minerals Recently found in the State.

H. G. Hanks, State Mineralogist, California:

Recognizing the importance to the State of the work in which you are engaged, and the gratifying measure of success which has already attended your efforts to establish a permanent geological and mineral collection, I take pleasure in offering you a series of written contributions upon the minerals and the geology of California. As these contributions will be based upon the observations I make in traveling through various portions of the State, and will often be written during the journeys, they will, of necessity, be somewhat desultory and informal, but I hope they will assist in making the varied and interesting geological features of California better known.

WM. P. BLAKE.

No. 1.—New Mineral Localities.

Erythyrite: Cobalt Bloom.—In minute mammillary incrustations, showing, when broken, radial aggregations of silky, fibrous crystals. Color, deep carmine or rosy red; also, peach-blossom red. Streak, the same color, but blue after the mineral has been heated. It gives the usual reactions for cobalt, arsenic, and water. Occurs, also, in massive, earthly aggregations of small fibrous crystals, of a rose-pink color. It is associated with an ore of silver and cobalt, in dark-colored earthy masses, a mechanical mixture, assaying at the rate of five thousand to six thousand ounces of silver to the ton, but the precise nature of which is not yet ascertained, in a gangue of heavy spar, containing, also, nodular masses of chalcopyrite (yellow copper ore). From the Bernardino range, southern California. This is believed to be the first observation of the occurrence of this species in the United States.

Rubellite: Rose-colored Tourmaline.—This very interesting mineral is now observed for the first time in California, in the form of long slender crystals from one sixteenth to one eighth of an inch in transverse diameter, with the usual triangular section. Color, a beautiful rose-pink, contrasting well with the matrix of white lepidolite. When ignited the color disappears and the mineral becomes perfectly white; infusible. Locality, Bernardino range, southern California.

Lepidolite—Occurs with the above in massive aggregations of minute pearly scales, both colorless and purple-red in color. It is traversed by the crystals of tourmaline. It fuses readily to a white enamel, and colors the flame next to the assay a dark crimson-red for a moment.

Cassiterite: "Wood Tin."—A single specimen of wood tin, a segment of a botryoidal mass, with concentric structure and dark brown in color; was found by Mr. Thomas Lane, of Laporte, in the bed of the middle fork of the Feather River, about three miles above Big Bar, Plumas County. The mass is about five eighths of an inch in diameter, and closely resembles the wood tin brought from Durango, Mexico, and that found in Idaho. The attention of placer miners should be directed to this, as other fragments may be found in cleaning up sluices, and thus lead to the discovery of the source of this valuable ore of tin.

BORNITE: Variegated Copper Ore.—This beautiful ore of copper is found upon the claim of Mr. A. J. Ford, at Light's Cañon, Plumas County, in a vein affording massive specimens three inches or more thick. In the same region there are veins of yellow copper ore and of massive Hematite.

No. 2.—Section from Merced to Coulterville and Big Oak Flat.

From Merced station, upon the Southern Pacific railroad, the line of section described in this contribution extends in a northeasterly direction, nearly transverse to the line of strike of some of the most interesting gold-bearing rocks of the Sierra Nevada.

Merced is situated upon the alluvial plains of the San Joaquin. The level and clay soil, noted for its fertility and adaptation to cereals, extends without change to the Six-mile House, where gravel begins to show itself and the soil is poorer and more arid. Another six miles, over a gently rolling gravelly plain, brings us to the banks of the Merced. Crossing by ferry to the right bank, we travel along the broad and rich bottom lands to Snellings and Merced Falls, passing plantations of Indian corn and cotton.

At Merced Falls, the first outcrop of the older rocks is observed. It is a hard bar of compact black clay slate, like roofing slate, very uniform in texture, in broad flat plates, standing vertically on edge, trending in remarkably straight lines northwest and southeast. This hard outcrop forms a natural dam, upon which the rapidly flowing water of the Merced has made but little impression. There is a fine water power at all seasons, which is partially utilized by a woolen mill. We here leave the river and ascend the hills to the northeast. The black slates carry numerous veins of white quartz, which have not been much prospected.

A few miles beyond the falls, the surface rises rapidly, and the slates give way to harder rocks. These are light bluish green in color, weathering in places almost white. They are evidently of sedimentary origin, though much altered and changed from their original condition. They form the outlying belt of a series of heavily bedded conglomerates, sandstones, and shales, which, being harder and less susceptible to erosion than the slates, form the high hills and ridges. These elevations trend northwest and southeast, and are probably the northwestern extension of the Mount Oso range, which traverses a large portion of Mariposa County, and forms the western wall of Bear Valley, on the Mariposa estate.

The heavy and bold outcrops of the massive conglomerates composing this range are not readily recognized as conglomerates. Their composite character is obscure. Generally it is scarcely possible to recognize that the rock is made up of rounded bowlder-like masses. The bowlders which form these rocks are so much compressed, welded, and united in one apparently homogeneous plasma that the dividing lines and contact surfaces are obliterated, and cannot be seen except upon surfaces that have been weathered, and sometimes upon broad surfaces of fracture. Occasionally, where the metamorphic action has not been as strong as in other places, the original forms of the bowlders can be made out, and the masses stand out from the general surface. In decomposing, these old conglomerates reveal their origin by yielding a vast amount of hard bowlder-like masses, elongated and lens-shaped spheroids, which are utilized for fencing. These rocks are generally known and described as "greenstone," the color being light bluish green, and the mineral composition of the bowlders being like the greenstones. They offer a very interesting subject of study to the lithologist and to the student of dynamical geology. They border on each side the belts of slates in which most of the quartz veins are found, and have, next to the granites, best withstood the denuding and wearing forces of the elements, and thus have to a great extent determined the topography of the piedmont region of the Sierra Nevada.

Upon the line of the section herein described, such conglomerates occur in a number of parallel outcrops with slaty rocks between and belts of sandstone, the exact succession of which cannot be determined without painstaking investigation. The whole series occupies a breadth of about twenty miles between the slates of Merced Falls and the similar slates of Coulterville Valley. It includes at least two bodies of well defined pebbly conglomerates, in which the pebbles are small—not much larger than beans. These conglomerate beds lie parallel with bodies of argillaceous slate, and clearly demonstrate a succession of deposits formed in alternating deep and shallow waters. Approaching Coulterville, we descend the hills of greenstone conglomerate and pass suddenly upon the black slates of the valley. They greatly resemble the outcrops at Merced Falls, and probably are a repetition of that series. Here, however, they are especially interesting, as the matrix of the two chief lines of gold-bearing veins in California, the so-called "mother lode" of the State. In this valley, as also upon the Mariposas, and further north, there are two nearly parallel lodes of great size, the croppings of which are so bold and prominent, crowning the hills, as to be visible for miles.

The western lode rises between walls of black slate, and carries films and sheets of the slates in its mass, giving to it a more or less stratified form and a striped appearance when seen in cross sections, or as it stands in the mines. Such quartz is technically known as ribbon quartz, and is a great favorite with quartz miners. In the mother lode proper, a short distance further east, the quartz is more massive and solid, and is in close proximity to a belt of serpentine, and for a great part of its course follows and penetrates a stratum of magnesian rock referable to ankerite and magnesite. It is characterized by rusty outcrops and an abundance of foliated bright green mineral, to which the name "Mariposite" has been given. It appears to owe its green color to chromium and iron, rather than to copper or nickel. The quartz penetrates this magnesian rock so thoroughly as to form in many places a complete network of veins branching off from the chief body.

Beyond the veins and magnesian belt the slates are seen again for a short distance, and are succeeded by greenstone conglomerates.

Beyond these, on the road to Big Oak Flat, there is a heavy body of syenite forming a hilly region traversed by the road for ten miles north and east to Priest's, on the Yosemite road. From Priest's, westward, there is a region of massive hard black slates, which appear to belong to the series of formations in which the limestone belt of Sonora and the Hite group of veins occur. I regard them as older than the mother lode series of slates, and believe that they belong to the period of the carboniferous; the reasons, in part, for this belief being their stratigraphical relations to other formations and the abundance of carbonaceous matter which they contain.

The mother lode slates have been shown to correspond in age to the jurassic period. I am inclined to refer the greenstone conglomerate series to the trias.

The whole series of formations embraced in the section give satisfactory evidences of extensive plication and subsequent erosion. The dips are generally eastward and at a high angle.

No. 3.—Coulterville to Chinese Camp.

Leaving for the present, a notice in detail of the mother vein, we follow its course approximately to Chinese Camp, near Sonora, in Tuolumne County.

Crossing the line of the great vein at Coulterville, the road leads, for a short distance, over an outcrop of the heavy greenstone conglomerate, bordering the slates on the west. From that point to Priest's hotel, on the Yosemite road, a distance of ten miles, the rock formations are entirely different from those of the valley, being granite and syenite. The hills rise higher and the topography changes. The altitude at Coulterville is about one thousand seven hundred feet, and the road, upon the granite formation, is about two thousand five hundred feet. Priest's is between two thousand three hundred and two thousand four hundred feet in altitude. The hills are but sparsely timbered, and generally are wholly covered by a dense growth of chemisal. When this is in blossom, it never fails to remind one of the heather-covered downs of England, although it is comparatively gigantic in growth.

These high hills, which have been generally regarded as barren and worthless, are now being sought for and utilized for grain-growing and vineyards. Wherever water can be distributed over the surface, the granitic soil yields excellent crops of wheat. The vine takes kindly also to this soil, and particularly where there is an excess of iron oxide, giving a red color to the earth. Probably the greenstone conglomerate hills are better than the granite. It is said that wherever the vines get well started they do not afterwards require irrigation. The fact that these hills can be covered with vineyards is extremely important, as greatly extending the area of the vine-producing region of the State.

About midway between the points mentioned, the syenitic granite gives way for a short distance to a thin belt of gneissic rock and a metamorphic slate. These formations are bordered by felsites, which, in decomposing, have formed banks and layers of koalin, cut through by the graded road.

Near Priest's, some gold-bearing quartz seams, or veins, have been found traversing the granite. These probably hold about the same relation to the veins of the slate belt as the veins in the granite at West Point, farther north, do to the veins in the slates of Amador County.

At Priest's we pass upon another and heavier belt of slaty rocks, which are more massive, harder, and appear older than the jurassic slates of Coulterville. This formation extends east and southeast from this point, and is probably the same body of hard black slates reaching southeast to Hite's Cove and beyond, carrying the celebrated Hite vein and others. These slates are regularly stratified, and appear to be traversed by dykes of trap or greenstone.

From Priest's to the Tuolumne River at Stephen's Bar, the road leads in a northwesterly direction. The granite and syenite appear to thin out, for directly after leaving Priest's the greenstone conglomerate takes its place. The road descends rapidly between high chemisal covered hills, underlaid by the conglomerates, to Culbertson's in the valley, only a mile west of Priest's, and one thousand three hundred feet lower.

At this point we are again upon the mother lode formation, and follow it down Moccasin Creek to the Tuolumne. Looking back toward Coulterville, the view is interrupted by the peak of Penyon Blanco, the crest of which is formed by the massive blocks of white quartz of the mother vein. About Culbertson's the vein is split up, and does not come boldly to the surface. Lower down the valley it appears in the foothills on the right bank, and on the left bank there are heavy outcrops of serpentine, extending nearly to the Tuolumne, where the slates are found largely developed. The mouth of Moccasin Creek is only about seven hundred feet above tide. Running parallel as it does with the great vein for several miles, it might be expected to be rich in gold, which was the fact. It has been worked and reworked with profit, but now the gravelly bed is being leveled, and vineyards and orchards cover its surface and give a perpetual bonanza to the appreciative sons of Italy. The wonder is that more of our American young men and women do not avail of the many opportunities to make charming and profitable homes in the forsaken gold fields of California.

We cross the river in a boat and follow the left bank for about two miles to Jacksonville, noted years ago for its figs and oranges. The general direction of the river corresponds with the strike of the formations, but it soons turns abruptly to the west, and cuts across the slates and sandstones of the chief gold belt. Conglomerates and outcrops of serpentine with traces of the mother lode are also found; and these rocks continue, with a regular northwest trend, to Chinese Camp, eight miles southeast of Sonora. This place is situated in an open, gently rolling country, at an altitude of about one thousand three hundred feet. Surface gold washings were very extensive in this vicinity, and sustained a large population of miners for years, but the diggings are now overgrown with grass, and many of the once well-filled stores are vacant.

No. 4.—Chinese Camp to Sonora.

In my last communication, the course of the mother lode was followed from Coulterville to Chinese Camp, and it was shown that for most of the distance northwest of Penyon Blanco the lode does not crop out strongly, and appears at intervals only. The formations, however, continue unchanged, and the line of the lode is east of Chinese Camp.

Leaving Chinese Camp, and passing northeastward nearly at right angles to the strike of the rocks, we first cross the eroded outcrops of the conglomerates, and then over a belt of slates standing on edge, but presenting an almost flat surface, greatly resembling the outcrops at Merced Falls. This smooth and apparently planed-off outcrop is in strong contrast with the sharply serrated edges of the slates standing above the soil like tombstones, generally known among the miners as "gravestone slates." The difference of surface is very likely due to a difference of internal grain; the absence of the elongated structure made by pulling or stretching the strata during the period of plication, to which we may refer the sharp ellipsoidal outcrops of the slates in a great part of the gold region.

Beyond these outcrops, north and west, there is a belt of greenstone conglomerate, succeeded by serpentine, apparently the prolongation of the serpentine belt traced northwestward from Coulterville and along the Tuolumne. Pliocene gravel also makes its appearance in remnants of a tableland formation; and a short distance beyond, the lava-capped beds of Table Mountain bound the view from north to west.

Thinly bedded clay slates come to the surface east of the serpentine and continue up to the outcrop of the mother lode, about one mile west of Jamestown. The lode at this place crops strongly, and forms the crest of a ridge upon the flanks of which there are heavy deposits of quartz gravel, evidently derived from the disintegration of the vein. The many pits and trenches in this gravel clearly indicate its valuable auriferous character, and at the same time, show that the vein is not a mere barren outcrop of quartz.

The vein is accompanied by many branches and veinlets penetrating the adjoining slates in various directions. It follows the formation and trends northwest towards Table Mountain, under which it disappears. It would be interesting to ascertain what the fineness of the Table Mountain gold is, compared with the fineness of the gold from the vein. There can be little doubt that the Table Mountain deposit was greatly enriched below the mother vein by the gold broken from its croppings upon the banks and in the bed of the ancient river, along which the deposits and lava overflow of the present mountain were formed.

The lode is in the midst of the clay-slate formation which extends to and beyond Jamestown. East of this place the slates become harder, more massive, and are traversed occasionally by quartz veins. All the formations trend toward Table Mountain, and are there covered from view. As the slates become harder, the surface of the country rises from one thousand four hundred feet elevation at Jamestown to nearly one thousand eight hundred feet at Sonora; this may be due in part to a very hard dyke of dioritic rock just west of the town. Sonora is built upon hard, massive black slates, resembling those beyond Priest's, and at the Hite mine, belonging, I believe, to the most eastern belt of slates of the Sierra; these black argillaceous slates are firm and hard enough to be quarried for building purposes. They are gold-bearing, and at the present time there is a most notable development of a vein within the town limits, from which fabulous amounts of gold are taken by two men, the metal being so abundant that but little crushing in a hand mortar is required to free it from quartz.

The limestones at Sonora, bordering the slate formation on the east, constitute one of the most interesting geological formations of the

State; they are here developed over a considerable area, and stretch for many miles to the northwest, to Columbia, Shaw's Flat, Murphy's, and beyond, and southeastward it is believed to reach to Hite's Cove, and beyond it, though I have not traced them in that direction. In a section which I shall hereafter give, from Mariposa to Hite's Cove, I shall show the similarity of the formations; that there are several distinct strata, or beds, and that some of them abound in fossil encrinites. The Sonora outcrops have failed, so far as I know, to give any evidence, by fossils, of their age or place in the geological scale. There is no doubt, however, of their deep-sea marine origin. They show distinct stratification, and alternate layers of gray, white, and blue color. The stratification is nearly vertical, and the beds, being of different degrees of solubility, now present a very extraordinary and uneven surface, especially where, in the flats and valleys, they were covered with alluvial gravels and clays. In such places, notably in Columbia and Shaw's Flat, the outcrop consists of a succession of sharp, irregular bodies of limestone, separated by deep, fissure-like chasms. The masses, in many instances, seem like loose bowlders, and where the soil and gravel were removed by mining, they toppled over. Such a surface proved to be wonderfully retentive of placer gold, and the harvest from this strangely irregular surface of limestone was very great. Miners have worked the crevices to great depth, and there is reason to believe that the bottom of many of the chasms has never been reached. A similar formation occurs in the Ural Mountains, and was described by Sir Roderick Murchison. A reference to this, and a more complete notice of the Sonora deposits, with figures, will be found in my report to the United States Government in 1853 to 1855.

The cause of the uneven surface is not, as is generally supposed, mechanical wearing away, or erosion, but is chiefly chemical. It is due to the solvent action of carbonated water percolating through the soil or standing in the undrained and swamp-like flats. As the rock was dissolved the gravel and gold sank down into the cavities and crevices far below the surface upon which they were originally laid down.

At the time of my first visit, in 1854, the whole limestone belt was populous with miners, and many relics of the pliocene age were brought to light and were often lost to history and science. These for the most part consisted of teeth of elephants, the mammoths, and of the mastodons of primeval days, when they roamed through the forests and glades of California with the tapir and hipparion. Whether the progenitors of the modern Digger Indians were "there to see" is still an open question, though some cracked skulls are thought to bear evidence on this part.

The late Dr. Snell, of Sonora, was an enthusiastic collector of aboriginal stone implements and relics which have been peculiarly abundant about Table Mountain, and were supposed by the doctor to be of great age, even antedating the lava flow. This, however, is very doubtful. As the subject is very interesting, and the facts are important in the discussion of the antiquity of man upon the globe, I propose to make them the basis of a separate contribution.

Since the death of Dr. Snell, his collection appears to have been scattered. I did not find in Sonora any one who could give me an account of it. Casts of some of the specimens have been sent to the Smithsonian Institute; and the doctor presented me with a collection of specimens some years before his death. At the same time, I made exact drawings of some of the more important pieces, copies of which I will send you for publication in your annual report.

No. 5.—Occurrence of Vanadates of Lead at the Castle Dome Mines.

The occurrence of the rare mineral *vanadinite* at the Castle Dome mines is sufficiently interesting to receive a special notice in this series, although the locality is just beyond the line of the State, across the Colorado River, and in the Castle Dome district, Arizona.

During my recent visit to that district I collected a variety of specimens with the intention of preparing a full memoir upon the species, and its association with Wulfenite and the other beautiful ores of the Castle Dome veins, but as the box containing the material has not arrived I must be content with sending you this preliminary notice.

Vanadinite, which occurs in considerable abundance in the claim known as the "Railroad," is a rare mineral, and has not hitherto been found in the United States, if we except some minute microscopic crystals, mixed with Wulfenite, found in the ores of the Wheatley mines, at Phœnixville, Pennsylvania, and referred to the species Descloizite, also a vanadate of lead.

The vanadinite occurs in groups of hexagonal prismatic crystals with curved sides, tapering at each end, and closely resembling pyromorphite in form and grouping. These crystals are rarely over one sixteenth of an inch in diameter, being generally half that size, and less than three sixteenths long. They are in confused aggregation, forming crusts and filling cavities in the decomposing ores of lead, and also on fluor-spar. Some of the crystals are cavernous, presenting the appearance often seen in phosphate of lead. One side of a crust of crystals is often in distinct hexagonal crystals, and the other consists of an aggregation of minute crystals grouped in arborescent forms, and differing in color from the coarser crystals. The larger crystals are generally light brown in color, with a bronzy luster. The smaller crystals are lighter, and are of various shades of orange yellow, becoming, in places, nearly white with a silvery satin-like luster, due possible to a pellicle of some other mineral covering the surface. The yellowish brown crystals have a wax-like appearance and luster.

The difference in appearance in the crystalline crusts, their difference of aggregation and color, suggests the probability of several species. It is possible that Dechenite, Descloizite, and Mimetite are represented; also Eusynchite. The behavior with nitric acid is different, some crystals showing a distinct separation of red vanadic acid, and others giving but a slight reaction.

The Wulfenite crystals in association are extremely brilliant and light yellow in color, presenting a beautiful appearance upon a background of green fluor-spar, or white crystalline carbonate of lead.

There is great need of investigation of the composition of the many varieties of yellow, red, and brown crystals from Castle Dome and Silver District, now usually referred to Wulfenite, though it is probable that several species are represented.

The Castle Dome vanadinite is totally different in appearance from the red crystals of Silver District. At Castle Dome the vanadium appears to be present in varying proportions in the crystals of different appearance, though all hexagonal, and to be associated with arsenic acid in the mineral species, Mimetite.

Some of the specimens, giving strong arsenical odors on coal and having the external characters of mimetite or arsenate of lead, give also characteristic reactions for vanadic acid, though not to the same degree, or so distinctly, as other crystals where the arsenical reactions are weaker. The strongest reactions for arsenic, so far obtained, are from the crusts of small aggregated crystals of a light brown or straw-yellow color and wax-like luster. The deportment with nitric acid varies, but all the varieties dissolve and give finally yellow solutions, which become green and blue where deoxidized by organic acids or alcohol. The occurrence of vanadic acid in mimetite is not unknown, Domeyko having found it in mimetite from Mina Grande, Chile.

In all of the specimens so far examined, whether the light yellow, barrel-shaped crystals, or the long, tapering, hexagonal prisms, or the dentritic aggregates, reactions for chlorine are obtained, and the yellow nitric solutions become green by heating with alcohol.

It is interesting to note here that recent researches by M. Bertrand go to show that the hexagonal crystals of mimetite are compound crystals, made up by twinning of orthorombic crystals. This has been shown by the study of the optical characters. While pyromorphite is truly hexagonal, showing only one axis of symmetrical polarization, mimetite was found to have two optic axes. It is possible that we may find crystals large enough from Castle Dome or Silver District to examine with the polariscope, and ascertain whether they are in reality compounded or single.

Vanadinite also occurs in beautiful crimson red crystals, in the Hamburg mine, at Silver District. These crystals are small, but are beautifully distinct hexagonal prisms or "berylloids," being similarly shaped, and are terminated by a flat plane at right angles with the planes of the prism. The terminal edges are replaced by a minute brilliant plane, and in one or two of the crystals a plane replacing one of the solid angles has been observed. The material at hand is insufficient to give me the best specimens for examination by the goniometer, so as to accurately measure the inclination of these terminal planes to the base or sides. I have, however, mounted one of the minute crystals in hand, and find the angles of the prism apparently equal, so there is little doubt of its truly hexagonal form. The seemingly partial termination or modification of the terminal edges in some crystals raised the question whether, though apparently hexagonal, the true form might not be rhombic.

The streak or powder of this mineral is salmon-colored or orange red.

It dissolves completely in dilute nitric acid, but in strong nitric acid, if added in small quantities, there is a separation of a red powder, which floats off in the acid and is then dissolved, giving a yellow solution, which, after standing some hours, becomes green. It is also turned green in a few moments by the addition of a small quantity of alcohol, and this green solution, on boiling, turns blue. These reactions are characteristic of vanadic acid.

With microcosmic salt in the outer blowpipe flame, we obtain a yellowish-green glass, which in the reducing flame is changed to an emerald green, when cold.

With borax in the outer flame an olive-brown bead results. Strong reactions for chlorine are obtained by the silver test.

Some of the crystals are light amber colored and are transparent, and some of them are much darker in color near the terminal plane than at the foot of the prism, where it adheres to the gangue.

In the Red Cloud mine, at Silver District, and likewise at the Silver Glance mine, numerous fine specimens of tabular crystals of Wulfenite have been procured from time to time for the past two years. These crystals are often half an inch across, and are from one sixteenth to one eighth of an inch thick. The chief peculiarity is their fine red color, very different from that of ordinary molybdate of lead, and contrasting strongly with the yellow Wulfenite crystals from the same localities, and from those also of Castle Dome. These red crystals I provisionally refer to the vanadiferous variety of Wulfenite.

A complete analysis is, however, needed to show the composition of this and other allied varieties found in other claims at Silver District, notably at the mines opened by Bamber & Sons—"The Oakland Boys' claim."

The first red crystals of Wulfenite observed in the United States were extremely small, being almost microscopic, and were implanted on the ores from the Wheatley mine, at Phœnixville, Pennsylvania. They were found by the writer, and the red color was at first supposed to be due to chromic acid, but when the mineral was procured in quantity sufficient for analysis, Professor J. Lawrence Smith showed that the red color was due to the presence of vanadic acid. The Silver District specimens now afford sufficient material to permit of a quantitative determination of the constituents.

Beautiful octahedral crystals, of a reddish-brown color, are obtained at the Oakland Boys' claim. I regard these as another vanadic mineral, possibly a vanadic variety of Wulfenite; though the form and the color are so different from the form and color of undoubted Wulfenite in the same district, I am inclined to regard it as a distinct species, or, at least, a well characterized variety. I regret that the specimens I expected have not arrived, thus preventing my making tests and giving a specific description.

I am indebted to Mr. Wm. P. Miller, the General Superintendent of the Castle Dome mines and the smelting works at Melrose, for assistance in procuring some of the specimens which I have been describing. Some were obtained by me at the mines, April, 1880, and others at the time of my last visit to the mines this past Spring.

No. 6—Occurrence of Tin Ore (Wood Tin) in California, Idaho, and Montana.

In contribution No. 1, I made brief mention of the occurrence of stream tin in the alluvions of the middle fork of the Feather, about three miles above Big Bar, in Plumas County. The only evidence so far found is a single specimen saved and shown to me for determination, by Mr. Thomas Lane, of Laporte. This observation becomes more interesting from the discovery of similar ore in Idaho and Montana. On visiting northern Montana, last Winter, I was surprised to find that stream tin occurs in many of the streams of the granitic region of the Bitter Root Mountains, and in some localities in sufficient abundance to justify the hope that washing for this ore may be conducted with profit. At Glancy, in Jefferson County, not far from Helena, the mineral occurs in the creek, and is washed out by the placer miners. At Dr. H. M. Hill's, at this place, I saw about one hundred pounds, some of which was taken from Prickly Pear Creek, on the Snake. This ore is in small, rounded, light brown grains, about the size of peas or kernels of corn. It is accompanied by wolfram and by white, brilliant crystals of topaz, like those with the Durango tin. There are other gems, in a broken, fragmentary state, looking like sapphire and aqua-marine, and like zircons.

Amongst other localities where tin ore has been found, I cite: French Bar, about eighteen miles from Helena; at the head of Ten Mile, in the "Basin;" and in Basin gulch. Recently I have received a sample of fine quality from Mr. Benjamin Franklin, of Deer Lodge, Montana, who washed it out, some years ago, from Peterson Creek. This creek heads in the main range, and flows a short distance in a southwest and then in a northwest direction, and empties into the Deer Lodge at the southerly line of Deer Lodge City. The locality is about ten miles southeast of Deer Lodge City. The country rock in the vicinity is granite. It is said to have been found also across the Missouri, above Fort Benton, and at the other extreme, near Salmon City, on the Snake River, in Idaho. It will be remembered that, in 1866, I directed attention to the fact that stream tin had been found, in beautiful brown masses, on Jordan Creek, Idaho Territory, in the placers of that stream. This ore is identical in its appearance with the Montana ore, and neither can be distinguished from the Mexican specimens.

The many points at which the ore has been found in Montana and Idaho indicate that this important ore has a wide and general distribution in the granitic region of the northwest, particularly in the Rocky Mountains, at the headwaters of the Missouri, and in the western drainage, including the streams flowing from the Bitter Root range, especially in the Snake and the Salmon, and their affluents.

It should be added, that at the International Exhibition, Philadelphia, 1876, Dr. Hill exhibited a bar of metallic tin about six inches long, two inches wide, and one inch thick, which he reduced from Montana ore. In the wealth of objects exhibited at that time, this little bar did not receive the attention and mention to which it was entitled, as representing a possible metallurgical industry of great importance to the nation. It is premature to say that any of the localities noted will yield the ore at a profit sufficient to justify working for the tin ore alone, but it is possible that such places may be found. Most of the placer miners are ignorant of the nature of this ore, and do not recognize oxide of tin in the smooth and hard stony fragments that load their sluices and pans, and are thrown out as valueless. It is, therefore, important to direct attention to these localities and to the ore. The distribution of the stream tin should be more accurately determined, and search should be made for the parent veins in the mountains at the points above where the deposits of tin commence. As this notice may be published in the Mining and Scientific Press, which deservedly has a wide circulation amongst the miners of the West, it is well to add that the wood tin, as found in Montana and Idaho, is in very smooth and heavy grains, and masses of a light brown, and also a dark brown color, with a concentric layering and a fine radial structure. It is as hard as quartz, as heavy as pyrites, and contains about seventy-eight per cent. of tin, though it is without any metallic luster or appearance.

No. 7.—Origin of Loess.

The mode of formation of the deposits known by geologists as Loess, is now receiving more than usual attention abroad. Several articles have appeared in the Geological Magazine of London, written by W. H. H. Howorth, and in the July number, Professor Baron Richthofen, now of the University of Bonn-on-the-Rhine, has a letter giving full expression to his views upon this vexed question of the Loess, which is generally admitted to be one of the most difficult problems of geology.

Although no well characterized deposits of Loess have yet been recognized in California, we have, within the limits of the State, certain deposits, at the least partaking of its distinctive peculiarities, and whose origin may throw great light upon the question of the origin of the Loess. In the dry lake system of the region west of the Rocky Mountains of North America, we find phenomena which may be advantageously considered in a discussion of the origin of Loess.

These dry lakes, or playas, as they are known in the regions of Arizona and Mexico, are also found in the southern part of California. They have been described by myself (Report Geological Reconnaissance in California, 1855, pp. 216, 220, 225), by Mr. Clarence King (Geology of the Forty-first Parallel. See, also, Report of Thomas Antisell, for a description of *Playa de los Pimos*), and by others. They occupy the lowest portion of the basin-shaped depression between mountain ranges, forming nearly level plains of hard, dry clay, in the same position in their lowest portions that water would occupy if the precipitation were sufficient to keep up a supply. They are usually at the foot of long slopes, extending upwards at a slight but increasing angle to the mountain ridges. A succession of wet and dry seasons is required for their formation. The precipitation being confined chiefly to the mountain, torrents are suddenly formed, often by the immense volumes of water known as "cloud bursts," which rush down the steep and confined cañons of the ridges and spread out over the slopes; materials, coarse and fine, are mingled promiscuously together and are carried out upon the slope, where the water, spreading out in many channels, drops the coarser and heavier debris near to the mountains, while the finer and lighter portions are carried further on to the lowest levels, and are there spread out in a temporary lake of shallow but muddy water. This water evaporates rapidly and leaves a soft magma of mud which soon dries up and becomes so hard that wagons may be hauled over it without forming a rut, but in its soft and half dried condition it is dangerous to venture upon it, and animals often become mired and lost in their efforts to reach water. This process of formation, now going on in Mexico and California, constitutes an important topographical feature of the Great Basin region and of the elevated mountain region, year after year, to an appreciable extent, and during the glacial era, or former periods of greater precipitation, the accumulation of clay was, no doubt, much more rapid than it now is. In places where the drainage into the basin is sufficient, we have permanent shallow lakes, with broad margins of clay, such, for example, as the sink of the Carson, in Nevada, and, in fact, we may include the whole lake system of the

Great Basin, with its former great extension in Lake Bonneville, of Gilbert and Lahontan, of King, and even the great lake valleys of California, such as the Tulare Lakes and the Colorado. The phenomena are all connected, and there is an insensible gradation from the playas to the permanent bodies of water, of which Salt Lake is the most extensive example.

But the conditions of sedimentation upon the playas are very different from those where the light debris is received in comparatively deep and clear water. In the thick muddy flood spread out over the dry floor of a previously formed deposit, there are no conditions favoring a sorting of the materials or regular stratification. By absorption of water, the old layers of clay near the surface become softened and incorporated with the new, and the junction is obliterated. In deep, and especially in saline water, where the subsidence of silt is more rapid than in fresh water, the process of sorting is more complete, and the coarser materials are deposited near the shores, while in the shallow flood of muddy water there is a promiscuous mingling of the sand and the fine materials, and they are spread out over a great extent of surface.

We may recognize in these peculiarly formed deposits of the playas a process of sedimentation differing greatly from that which is wholly aqueous. The origin of the playas may be said to be partly subaqueous and partly sub-aerial. The conditions and results throw great light upon some of the peculiarities of the lowest formation, for which no generally accepted explanation has yet been found.

W. Raphael Pumpelly has described deposits in China, referred by himself and by Baron Richthofen to the Loess, which are cut up in a remarkable manner by ravines, with nearly vertical sides, rendering the country almost impassable. In the Colorado Desert of California we find similar conditions. The ravines are found in a vast deposit of calcareous clay or loam, which is clearly lacustrine in origin, though probably the ancient lake was shallow and was subject to great alternations of levels, so that the deposits were often exposed to the air, according to the season, whether wet or dry. The similarity of the topography of the true formation—the one in China, described by Pumpelly, and the other in California, described by myself in "Geological Reconnaissance in California," where illustrations of the ravines in the clay are given, requires notice. In the recent communication of Professor Baron F. Richthofen he enumerates twelve characteristic peculiarities of the Loess, which he insists any theory of origin must explain. For convenience of reference, I cite these in slightly abbreviated form:

1. "The petrographical, stratigraphical, and faunistic difference of the Loess from all accumulations of inorganic matter which have been deposited previously and subsequently to its formation, and are preserved to this day."

2. The nearly perfect homogeneousness of composition and structure, wherever found in Europe and Asia, contrasting with sediment deposited from water.

3. Its deposition independent of altitude above the sea. In China, from a few feet to 8,000 feet, or more, above the sea.

4. The shape of the deposits. "In hilly regions, if little developed, the Loess fills up the depressions between every pair of lower ridges, and in each of them presents a concave surface; but where it attains greater thickness, it spreads over the lower hills and conceals

the inequalities of the ground. Its concave surface extends, then, over the entire area, separating two higher ranges in such a manner as to make the line of profile resemble the curve that would be produced by a rope stretched loosely between the two ranges." "This shape of the surface is precisely similar to that which is characteristic of the salt steppes of Central Asia." It must, however, be remarked, that just as in these, the development is frequently unequal on either side of a valley, and that the preponderance of the deposit on the same side can sometimes be observed in each basin throughout a larger region. "The lowest portion of the surface of larger basins is frequently taken up by stratified soil consisting of the finest particles of Loess, and exhibiting a strong impregnation with alkaline salts."

5. The composition of pure Loess, which is the same, from whatever regions specimens may be taken, extremely fine particles of hydrated silicate of alumina being the largely prevailing ingredient, while there is always present an admixture of small grains of quartz and fine laminæ of mica. It contains, besides, carbonate of lime, the segregation of which gives origin to the well known concretions common to all deposits of Loess, and is always impregnated with alkaline salts. A yellow coloring matter, caused by a ferruginous substance, is never wanting."

6. "The almost exclusive occurrence of angular grains of quartz in the pure kinds of Loess."

7. The complete absence of stratification. To this must be added the singular position of the laminæ of mica. When these are deposited by water they are arranged horizontally and accumulated in separate layers, while in Loess they are distributed without any order, and occur in every possible position.

8. The capillary structure caused by the occurrence of innumerable tubes, mostly incrusted with carbonate of lime, which have generally a vertical position, and ramify downwards like the roots of grass.

9. The tendency to vertical cleavage.

10. The fact that land shells are imbedded in immense numbers throughout the Loess, and that the most delicate shells are perfectly preserved. Fresh water shells are of extremely rare occurrence, as has been correctly pointed out by Mr. Howorth.

11. "The great quantity of bones of mammals found in the Loess, the genera and mostly the species, or next relatives, which are known to abound at present in steppes and on grassy plains. Herbivorous animals are represented, as well as carnivorous, preying on the former."

12. The fact that wherever Loess fills a basin between hills, the inclined slopes of these are covered by angular fragments of the adjoining rock on which the yellow soil rests. Layers of these fragments, beginning with a slight inclination and then passing into a horizontal position, extend from the hillsides for some distance into the accumulation of the Loess itself, separating it in the neighborhood of the incasing slopes into layers of varying thickness, while towards the central position of each large basin this separation ceases almost completely, and the soil is very homogeneous from top to bottom, even in those instances where the vertical thickness is 1,500 feet and more.

In conclusion, he says: "It is perfectly evident that no theory starting from the hypothesis of the deposition of the Loess by water can explain all or any single one of these properties. Neither the sea nor lakes nor rivers could deposit it in altitudes of eight thousand feet on hillsides. Origin from water is perfectly unable to explain the lack of stratification, the profuse existence of capillary tubes, the vertical cleavage, the promiscuous occurrence of grains of quartz, the angular shape of these, the confused position of the laminæ of mica, the imbedding of land shells and the bones of terrestial mammals."

He fails to find a satisfactory explanation of all these peculiar characteristics of the Loess in the commonly accepted theory of lacustrine and fluviatile origin, and he propounds a theory of sub-aerial origin alone, attributing the formation to the slow but constant accumulation of dust, carried by the wind until it is arrested by vegetation. He says: "There is but one class of agencies which can be called in aid for covering hundreds of thousands of square miles in little interrupted continuity, and almost irrespective of altitude, with a perfectly homogeneous soil. It is those which are founded in the energy of the motions of the atmospheric ocean which bathes alike plains and hilltops. * * * Whenever dust is carried away by wind from a dry place and deposited on a spot which is covered by vegetation, it finds a resting place, and may be washed off and carried further away by the next rain if the ground is sloping, or it may be joined to the soil if the ground is flat or slightly inclined."

For this theory, Baron Richthofen claims he has the indorsement of Prof. Pumpelly (N. Y. Nation, April 14, 1878), who had before advocated a fluviatile origin, and, later, of Clarence King (by letter to Baron Richthofen), at least for the Loess regions of the Mississippi basin. M. Von Middendorff is also said to have changed his views in favor of the aerial origin. A great objection to this theory, which immediately occurs, is that we do not find any deposits of wind-driven clay forming at the present time. There are no examples known. All the deposits of wind-drifted materials are granular and arenaceous, without the agglutinating, binding nature of clay or loam. It is only the loose sands that are caught up and moved forward by the wind in appreciable amounts. The presence of clay cements the grains of sand together and binds them fast. The clay deposits of the playas and of the old lakes, such, for example, as the broad margins of the Tulares, are scarcely acted on by the winds that sweep over them. The hard surface is swept clean of sand by the windstorms, and the sands are piled in hills, but the clay is not appreciably worn away. The dust of wind-storm forages on the steppes and deserts is slight in comparison with the amount moved in a single rainy season by the floods issuing from the mountains and spreading over the plains. Any small amount of dust that the wind may distribute is more than returned to the playas and the lake beds by the drainage.

Residents of California are familiar with wind-driven materials and deposits, and in San Francisco have them at their very doors. The most extensive examples are the sand-hill area stretching across the peninsula of San Francisco from the ocean-beach to the bay, through "Happy Valley," and the sand-hills of the Colorado desert, and of the pass of San Gorgonio, where the cutting effects are very striking, and have been described; these are granular and loosely coherent, and are without any appreciable mixture of clay.

In the Rocky Mountain region the best example with which I am familiar, is upon the eastern side of the San Luis valley or park, on the western flank of the Sangre de Cristo range. Here, at altitudes of 5,000 feet, or more, the rocky asperities of the mountain-sides are covered and smoothed over by a deposit of fine sand, which has been carried up from the San Luis lakes or their desiccated beds by the prevailing winds. This sandy formation is covered with forests, and is not without fertility, but its granular sandy nature is evident, and it bears no resemblance to the horizontal formation of Loess. It is, however, the best example of which I have any knowledge in favor of the sub-ærial theory.

A similar objection, that we do not find such accumulations now going on, has been raised by Mr. H. H. Howorth, who sees in the Loess formation the evidences of a great post-glacial flood, and an outpouring of volcanic mud. (Geological Magazine, January to July, 1882.) This suggests a careful consideration of the phenomena of the pipe-clay deposits of our ancient rivers—deposits which, however, are much more ancient than the deposits of Loess.

A full study of the formation of playas, and of the processes of sedimentation of rivers subject to overflow, and in shallow lakes in regions where there is an alternation of wet and dry seasons, will, I think, give a satisfactory explanation of all the phenomena of the Loess. The deposits of the dry lakes of California and Nevada differ from all other sediments. They have, in general, the same composition, consisting chiefly of clay and fine material miscible in water. They are formed at all elevations and where permanent rivers do not exist. They fill depressions between ranges of mountains, and joining in places insensibly with the slopes from the high ridges, present the concave surface described by Baron Richthofen, in his fourth postulate. And the observed preponderance of the deposit on one side or the other of a valley finds explanation in the greater floods in the higher ranges on the side exposed to the greatest precipitation, or on those best situated to receive the precipitation during the wet season.

During the dry season, the expanse of clay is under atmospheric influences, and is subject to the accumulation of more or less wind-driven sand, which, in the next period of flooding, becomes mixed with the clay. Sand is also brought down more or less with the floods. As the water dries up, more or less vegetation springs up on the surface, and is always found around the borders of the dry lakes, wherever sufficient moisture continues throughout the season. This may account for the tubes found in the Loess, ramifying like rootlets. The tenth and eleventh propositions are exactly met by conditions of formation of the dry lakes. So, also, the twelfth is satisfied by the distribution of the materials of the slopes, the coarser portions sometimes overlapping the finer, when an excessive flood has carried the coarser debris further from the ridges than usual. Wherever land shells occur upon the slopes or upon the vegetation of the borders of the dry lakes, the periodic floods would of necessity sweep them onward and entomb them in the clay. So, also, the bones of mammals may be swept before the rush of water and be left in the clay, together with those of animals mired in the endeavor to reach water or saline deposits, when the water is drying up. We may expect to find scales of mica in all positions, they being disseminated in the thick mud, and not being free to settle as they would in clear water.

Baron Richthofen has been led to his conclusions chiefly by the study of the Loess deposits of China, and his views have been given more fully in his work upon China—Vol. I, pp. 56 to 189—to which he refers in his article. I regret that I have not been able to refer to this work. Mr. Pumpelly's descriptions of the same deposits are given in his memoir already cited, published by the Smithsonian Institution. There is, in addition, a paper by this author, on the source of the dust required to form such vast deposits, in the American Journal of Science and Art, Vol. XVII, 1879, p. 133.

Although I am familiar with the dust-storms, or "simoons" of the Colorado desert, and along the Colorado at Yuma and at Castle Dome, and in Arizona, I am not able to recognize in them a potency equal to the formation of deposits like the Loess. That there is a translation by the winds from one part of the desert to another of a large amount of dust, as well as sand, during the lapse of ages, there cannot be any question; but this is slight compared with the amount moved by rains and stored in sediments in interior basins, as has been shown in the case of the dry lakes. These desert areas are subject to rain storms and sudden floods in the "dry washes" or channels that intersect them. (It may here be noted, that last Winter the surface of the Colorado desert was covered by snow to a depth of six inches or more—a most unusual occurrence.) Such storms collect and carry off the dust. Wherever an outlet to rivers and the sea exists, or to a permanent interior lake, all such wind-driven dust is washed off, and much more with it, and is deposited in sediments in the usual form. And this, too, must be the case where the aerial dust finds lodgment upon a surface covered with vegetation, the loss by degradation being far greater than the gain by the deposition of dust. Vegetation, to the extent required to arrest and retain the dust, supposes of necessity a region of rains, and in all such regions there is a constant wearing away of the soil. It is, therefore, difficult to conceive of the growth of such areas by wind-driven deposits.

I am constrained to dissent from the sub-aerial theory, and to adhere to the theory of fluviatile and lacustrine origin, believing that in the phenomena of sedimentation in *shallow* water, whether in playas or on the borders of lakes or rivers, we have an explanation of all the peculiarities of the Loess.

I am not prepared to admit that the Loess deposits are everywhere identical in their characteristics, nor that they are absolutely without stratification. In the Loess of the Missouri, at Kansas City, for example, which in general has the peculiarities named by Baron Richthofen, except the presence of land shells and bones, there is obscure stratification, recognizable only when standing at some distance from the banks, where cut through by the streets. Close inspection fails to detect any layers or lines of parting. The vertical cleavage is strongly marked, and calcareous tubes and concretions occur. It is a sandy, ferruginous loam, and is extensively used, without admixture, for the manufacture of brick. The deposits of the river now forming are not appreciably different, except as to the concretions and rootlets, which we may readily expect to find only in such portions of the deposits as are exposed to the air.

FLOUR GOLD.

BY ALMARIN B. PAUL.

Henry G. Hanks, State Mineralogist:

DEAR SIR—In reply to your request for an article on Flour Gold, I will preface by saying that I have written so much in the same direction, and so little observance has been given to what are deduced facts, that it seems almost a useless task.

It is very singular to contemplate, when one knows there are so many experienced miners in California who admit every proposition, and yet persist in the coarse, slashing way of reducing our gold ores and the washing of auriferous earths. As I look back thirty-three years, and mentally view the crudeness of mining machinery, as our beginning in California, and along up to the present, I can see how, by degrees, we have moved on to greater perfection in both machinery for reduction of the ores, and care in amalgamation of the precious metals; and thus I know too much must not be expected all at once, because a few investigate closely and grasp the wastage of our present operations.

The past has been a dashing period, and the rush of things was as applicable in mining as in any general business. But the times are changing; we are learning more thrift, care, and economy of time and labor; so the new generation of mining men may be expected to calculate closer, and more fully utilize the wealth of their mining properties by greater care in all they do. To appreciate the present wastage of our golden wealth, it only requires a systematic, scientific, or practical investigation to show that, take all the mines of California, and, positively, not forty per cent. of the value of the ore is reduced to bullion. Now, I ask, is this intelligent mining in this age of our boasted advancement? Mine owners are satisfied when told their results show seventy-five or eighty-five per cent. of the value of the gold contained in the ores, when, nine times in ten, it is simply a belief that they do, and is not founded on investigation, as an investigation would show quite the opposite.

The hundreds of experiments I have made, and results of others, as detailed in over two thousand letters that I have received within the past ten years, gives me unmistakable data to write from, and when I say I know, I do know, and for the good of the mining interest, and for an increase of the gold product to our State, I seek to impress the facts upon others. To get down to a close comprehension of the flour gold question, I assert that the original condition of coarser gold is as flour. It may be better comprehended, when I say it is flour of the rocks, and as such permeates the congenial metal-bearing matrix. The coarser particles of gold are aggregations of these finer atoms; aggregation being by attraction, pressure, and time, we do not yet fully comprehend the electric and magnetic laws, as they bear on, first, the deposit of gold in the veins, and, second, the aggregation of atoms, or they might explain still more.

Flour being, as I believe, the original condition, it is apparent that the value in gold-bearing rocks is of this character; hence, large assays and small returns in milling. It is often, I admit, that we find coarse gold which may outweigh the finer atoms, and yet this does not argue against my assertion, or prove that the atoms associated with the coarser are not desirable to secure; besides, we do not know how many thousand or million of years it has taken to aggregate the larger nuggets of gold. In gold-bearing sulphurets, all know that gold is, in the majority of instances, so infinitesimal that even very scientific men have declared it to be a sulphuret of gold, and not metallic. At my office I can show those interested in the subject, gold so fine that full twenty minutes is required for it all to settle to the bottom.

To illustrate further, I will now give you some experiments and a few extracts from letters, which will represent the many on the same subject:

"They returned me by sampled assays from my ore, $80 per ton, and I cannot get more than $10 by mill working."

"We have worked our ores in arrastras, and failed. We can save only about forty per cent., and we have no base metal to contend with. I have saved about $20 a ton, and can get about as good a show out of the tailings as out of the ledge before working, and I have worked in quartz for ten years."

"The first lot of ore went $18, the second $6 25, per ton—tailings assay, $60. We quit."

"Mr. J—— told me he had ore valued at $30, and only got from $10 to $15 out of it. There is no proportion between assays and yields. The rock I send you average, assay, $30. All I can get is $7."

"Extend tests as far as you may, on a smaller or larger scale, and wastage stares one in the face at every turn."

A practical test of muddy water which flowed from two first class mills of Grass Valley, the water being taken up three fourths of a mile below the mills, was made some years ago by Mr. McDougal, who kindly allowed me the copy as follows:

First test of twenty gallons showed	$1 10
Second test of twenty gallons showed	2 13
Third test of twenty gallons showed	95
Fourth test of twenty gallons showed	83
Fifth test of twenty gallons showed	1 02
Sixth test of twenty gallons showed	1 13
Seventh test of twenty gallons showed	97
Eighth test of twenty gallons showed	3 12
Ninth test of twenty gallons showed	1 07
Tenth test of twenty gallons showed	63
Eleventh test of twenty gallons showed	1 01
Twelfth test of twenty gallons showed	90
Average	$1 18

It was estimated 576,000 gallons of this muddy water flowed by every twenty-four hours, which, according to these tests, contained $339 84 of float gold, to say nothing of loss by imperfect pulverization.

A friend of mine concluded he would make a test of some slums in a tank, which received water for the battery, and after it had run to the tailing bed, from thence to a well, where it was pumped up and flowed through a sluice to the tank—result, $89 per ton.

It is useless to enumerate further; the mere assertion of such a heavy loss being sustained in our quartz milling operation, it would seem, should inaugurate a close investigation and for ways being devised for better results. Although the loss of gold in our quartz working is so large, the loss from our hydraulic and drift washing is fully as great, if not more. You will hear the hydraulic miner say, "We have no fine gold, ours is all coarse." All they get is coarser gold, and from this fact, they argue there is no fine, and no greater fallacy exists. How can they expect to get fine gold when no pains are taken to save it by separating and carefully handling the finer material, all of which can be done mechanically and cheaply? How can you expect to save finer gold when using from five hundred to three thousand inches of water, and carrying off rocks weighing often several hundred pounds each? Your paper on "Placer Gold" my idea exactly, and should be put in practice, for, if fully ac upon, in my humble opinion, it would increase the total yield fr our hydraulic and drift mines a million dollars a month. As back ing for these views, I will note the result of the clean up of the undercurrent of the Spring Valley Company, at Cherokee, in Butte County, California, which yielded $2,600; this gold was taken from material that had run through *two and one half miles of sluices*, and over nineteen undercurrents before reaching the twentieth, and even then Chinamen were working the tailings, and the Spring Valley is, no doubt, the most completely fitted up hydraulic mine in the State. Now, what must be the loss of those who are using a short line of sluices and no undercurrents, and those who labor under the idea that they can catch all the gold in the first few boxes? It is simply absurd.

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* Read before the San Francisco Microscopical Society.

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