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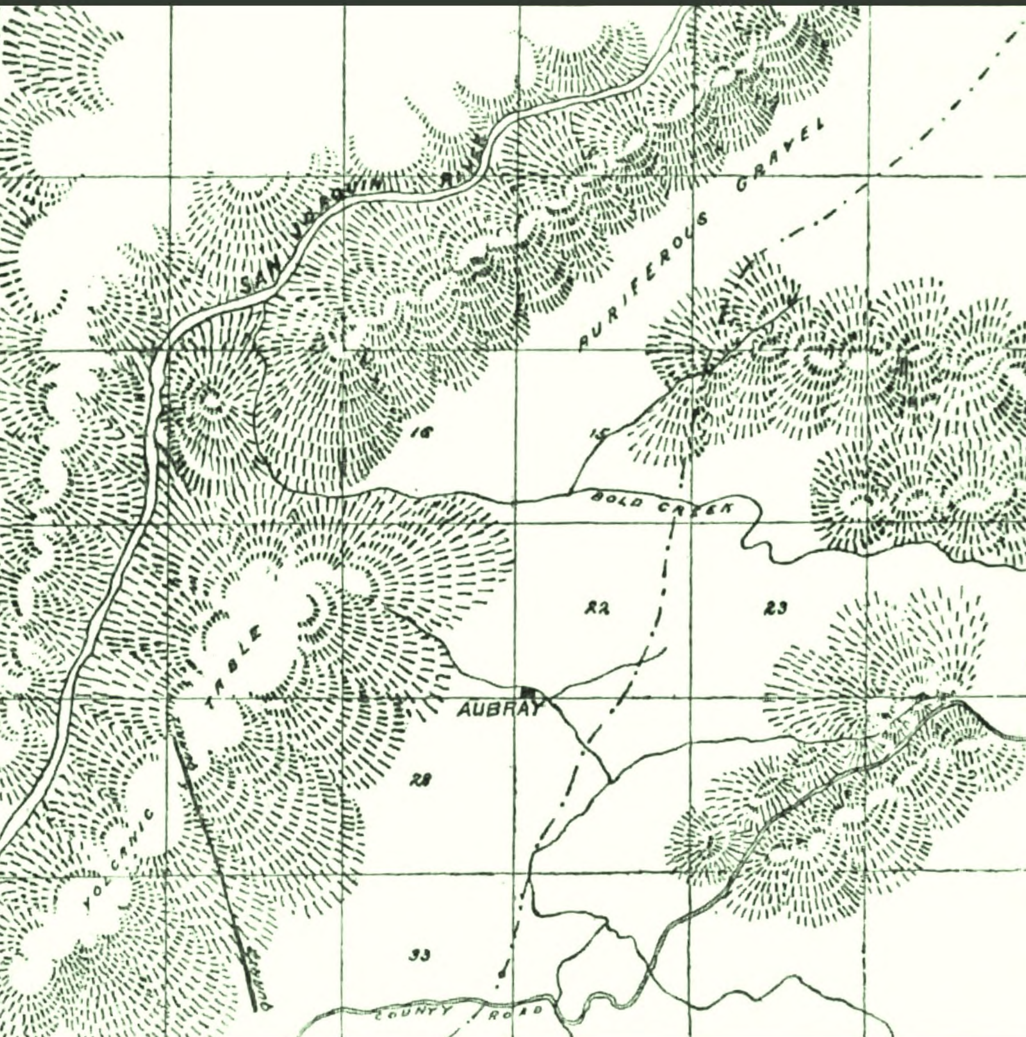

Annual report of the state mineralogist for the year ...

California State Mining Bureau

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REPORT OF TRUSTEES OF STATE MINING BUREAU.

The work of the Bureau under the able and efficient supervision of the State Mineralogist and his corps of learned and experienced assistants has, since the last report, made most gratifying progress. Commendations from all sections of the globe, ranging from men eminent in the domains of pure science, through the ranks of practical toilers down to the mere curiosity hunter, are on file subject to inspection.

These letters afford an eloquent tribute to the practical worth of the Bureau, and an approval of the intelligent liberality of the State Legislature.

It should be borne in mind that the gold, silver, copper, lead, antimony, quicksilver, and other metals, with which our State is so richly endowed, are not, by any means, the sole object of research and investigation. Building stones, earths, paints, cements, oils, gas, asphaltum, gypsum, lime, sand for glass making, phosphate rocks, mineral fertilizers, medicinal waters, and many other of our undeveloped resources come within the scope of investigation, and have lead to, and will continue to lead to the investment of many millions of dollars within our borders. That this is no mere phantom hope, but a tangible verity, may be proven from the records and testimony of the officers and employés.

Of the numerous economical enterprises due directly to information acquired at the Bureau, we may mention the following as typical examples: The opening of a large quarry of building stone in one of the foothill counties; the manufacture of plate and crown glass; the exploitation of a most valuable borax-bearing mineral; the starting of a manufactory of natural cement, together with gypsum, lime, and plaster works, all of which might have lain dormant but for the intelligent investigation of the staff of the Bureau.

We deem it safe to affirm that the money voted by the Legislature for the support of our institution has already induced cash investments in this State aggregating over one million of dollars; in a word, more than tenfold the sum total of the whole appropriation.

As an adjunct to and quite akin to the avowed purposes of its foundation, the Museum of the Bureau has been visited by many thousands of school children, who have found therein a striking object lesson as to the vast natural wealth of California. They responded in great numbers to the invitation of the Mineralogist, and were for days busy with pen and pencil taking notes and making sketches of the many objects of interest therein exposed.

THE MUSEUM.

The specimens which have been classified and placed on exhibition in the Museum during the past year number over one thousand five hundred, and we have found it necessary to procure five large cases to accommodate them. When the ninth report was issued, mention was made of the fact that the rooms of the Bureau were fast becoming too crowded for a proper display of the valuable collection; it is therefore

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Haas, Fred.
Haft, E. E.
Hale, E. T.
Hall, F. S.
Hall, W. H.
Hambleton, John
Hamilton, C. A.
Haskins, D.
Hasslocher, Dr. E. Von
Hayes, Dr. A. H.
Henderson, Warren
Heslewood, J. A.
Hessletine, Benj. C.
Hibbert & Burris
Hill, Benj.
Hobson, J. B.
Holden, J.
Hooper, Edw.
Hughes, D. T.
Hunt & Ellison
Hutchinson, J. E.

Irelan, Wm., Jr.

Janin, Louis
Johnston, Dr. W. D.
Jones, Edward
Jones, Robert H.

Keyes, W. S.
Kikuchi, J.
Kinrade, J. J.
Knowles & Hosmer

Lawson, D.
Leonard, C. W.
Lewis, S.
Lindsey, W. E.
Lytle, J. A.

Maguire, J. W.
Manser, Thos.
Marston, D. A.
Mason, W. Q.
Mayer, H.
Mayer, L. W.
McConnell, C. H.
McCully, Thos. J.
McDonald, M. J.
McNary, G. K. W.
McNear, G. W., Jr.
Merritt, C. W.
Miller, D. M.
Miller, R. W.
Miller, Wm. P.
Monks, Miss S. P.
Monteverde, F. E.
Morehouse, Mr.
Morrisey, Peter
Morrow, N. L.
Mosgrove, D. L.
Murphy, Thos.
Myer, H. H.

Neff, J. H.
Nettleton, Geo. O.
Nichols, Dr. Geo. B.
Noble, Mr.
Norton & Eckman
Noyes, Jas. A.

O'Gorman, J. F.
O'Neil, D.
Ordway, John H.

Perry, Mrs.
Petersdorff, C. F. Von
Pluth, Marcus
Pico Oil Company
Pittsburg Gold Mining Company

Railton, E. M.
Randol, J. B.
Reilley, Geo. H.
Reimers, W.
Robbins, J. H.
Robertson, J.
Robinson, A. J.
Rocky Point Granite Company
Rosenstock, M.
Rostron, John

Sala, B. A. De
Sanders, T. B.
Schnabel, Dr. M.
Scupham, J. R.
Sharp, W. L.
Sierra Buttes Gold Mining Company
Sirine, S. D.
Skinker, John
Smith, J. P.
Smith & Watrous
Smyth, Chas. D.
Spencer, Mr.
Sprage, Geo. E.
Steele, S.
Stockwell, H. E.
Stone, D. C.
Stone, F.
Stow, H. P.
Stuart, Robert
Swett, Joseph

Terrell, Geo. B.
Thistlewait, Chas.
Thompson, J. S.
Tioga District Mining Company
Tyro Gold Mining Company
Tyson Mining Company

Voy, C. D.

Ward, Mr.
Warden, Thos. C.
Watts, W. L.
Weckel, Fritz
Weiss, Richard A.
Wheeler, M. Allison
Whitaker, G. N.
Will, Mr.
Williams, Homer
Williams, Lewis
Williamsburg Scientific Society
Wilson, Mrs. C.
Wilson, L. Menifee
Wood, Harvey & Bro.

Young America Gold Mining Company

THE LIBRARY.

We are pleased to announce that the growth of the Library, through the medium of exchanges with home and foreign societies, and donations from scientists in all parts of the civilized world, has given to this department of the Bureau a value and importance second only to that of the Museum. Like the Museum, also, its growth has been chiefly attributable to donations and exchanges, as but few volumes, comparatively, have been added to it by purchase during the past year. These have been carefully selected, and embrace the latest editions of works of standard authority on mining, metallurgy, chemistry, etc.

The information most sought after by visitors to the Library is contained in monographs received from the writers in pamphlet form. They are necessarily very numerous, constantly increasing, and cover the widest possible range of investigation. They form a very considerable part of the Library, and, for convenience of access and ready reference, have been arranged in boxes, with the subjects of which they treat labeled thereon.

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To his Excellency R. W. WATERMAN, *Governor of the State of California:*

SIR: In accordance with the provisions of an Act of the Legislature entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880, I herewith transmit my report.

Very respectfully,

WM. IRELAN, JR.,
State Mineralogist.

SAN FRANCISCO, October 1, 1890.

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REPORT OF THE STATE MINERALOGIST.

The map accompanying this report, as a preliminary mineralogical and geological map of the State of California, has been, with the exception of the mineralogical and geological work from the field researches conducted by the Mining Bureau, and corrections made where possible, compiled on a scale of twelve miles to the inch from the twenty-five atlas sheets prepared by the State Engineering Department, on a scale of four miles to the inch. These atlas sheets were compiled from public surveys of the United States Government in as careful and correct a manner as the frequent discrepancies in those surveys allowed. These discrepancies are due partly to bad surveying, caused not always by bad intentions, but frequently by employing indifferently trained deputy surveyors; due also, no doubt, in many cases, to intentional removal by settlers of already set Government corners, and by subsequent starting from or connecting with such wrongly placed corners, and also due to a very great extent to the faulty system of contract surveying, allowing deputies to spread their contracts in patches all over the State without proper connections with meridian or standard lines, instead of having those meridian and standard lines extended over the whole State by competent Government surveyors by day work in the most careful and approved manner, and then have the work between standard lines done by contract. So it frequently happens that parts of standard lines brought together by subsequent surveys show breaks of several chains up to a mile, where they should be continuous east and west lines. Discrepancies like these are easily understood by surveyors or those familiar with surveying, but the general public is led to believe that gross carelessness, or worse still, gross frauds have been committed.

That some fraudulent surveys have been made seems to be the general belief, but taking all above mentioned circumstances into consideration, one comes to the conclusion that the public surveys are better than they are generally believed to be. Still, many discrepancies exist, and a thorough investigation and correction of the same, even, requiring a great deal of field work and, therefore, a considerable outlay of money, would save endless litigation when the State becomes more densely settled, and property lines, even in the mountainous districts, have to be more strictly defined.

Judgment in the selection of one or the other of two conflicting surveys has lessened the influence of those discrepancies on the compilation of the atlas sheets to a great extent, and the compilation, therefore, of the accompanying map might be pronounced as having been done on as correct and reliable basis as could be hoped for under the circumstances. In the southern portion of the State, especially around Los Angeles, where the atlas sheets have not been kept up to date, the detail irrigation sheets, also compiled by the State Engineering Department, have been made use of to a great extent. The latest railroad lines opened all over the State have been obtained from the different railroad offices. In places not covered by public surveys, the maps showing the United

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largely the daily results. Even with the best endeavors, we frequently went wrong; nor, under conditions so abnormal, could it well have been otherwise; and then, to this all-prevailing ignorance of the industry with its inherent troubles, there were superadded troubles of an extrinsic character. When we became aware of, or had learned what should be done, the means were not always at hand for doing it. In these emergencies we had to improvise much, having recourse to temporary expedients of various kinds; all costly and the larger number of them being of dubious utility. In the state as above described, is it to be wondered at that we were tempted to make trial of methods and appliances that now seem to be absurdities? With farming and the other vocations entered upon in the early day, it was widely different, as our people were familiar with these pursuits and knew how to carry them on properly; but with this new and strange business of gold mining, conducted as it had to be under surroundings so perplexing and trying, it was far otherwise.

There prevails a notion that the then great richness of the mines, while yet comparatively virgin, more than compensated for the unintelligent and wasteful manner in which they were being worked, and that this era of ignorance, failure, and loss was one of marked prosperity and progress. This, though a popular, is a mistaken idea, mining during this period having, as a whole, in comparison with the present, made but moderate returns. As a fact, this industry was entered upon in the wrong way, every sound business principle having at its inception been reversed. It was so large when born that, its first expansive stage once passed, it shrunk on itself, its after growth having been left to later years.

And, as with gold mining, so also in silver mining was our first lesson taken in an improvident and otherwise bad school, a like vicious system having from like causes been early obtained.

If, instead of the rich free-milling ores of the Comstock, we had at the outset been forced, as at present, to deal mainly with those of an opposite kind, we would have learned the industry of silver mining and reduction at a much earlier date, introducing the skill and practicing from the start economy and care, which have since been found necessary. The industry of mining now has an upward tendency, the output of bullion having for several years past been on the increase. Prospecting has been active; many new mines having meantime been opened and equipped with plants. Numerous and valuable improvements have been introduced. More system and economy have been observed, and most old errors avoided.

In nothing is the progress lately made better exemplified than in the low grade ores, which we are now able to work with profit, instances of which will be cited and remarked upon in their proper places.

Electricity for transmitting power to mining machinery has, during the past year, been employed for the first time in California. With the large quantities of water we have in this State available for generating primary power, such use of the electric current opens here vast possibilities in the above direction, few other countries being so favorably situated as California in this respect.

As greater depths were attained in our quartz lodes, new troubles began to develop themselves. Not only was there more lifting to be done with increment of water to be taken care of, but the ores on the line of permanent water being reached, instead of being of the free-milling variety,

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given their personal services, housed our assistants, and furnished conveyances free of expense to add to our success, and I hereby take this opportunity to return thanks for their very much appreciated, kind, and generous liberality.

MINING ACCIDENTS.

Although the percentage of mining accidents occurring in California is not as great as in some other countries, more especially those largely devoted to coal mining, still the question presents itself forcibly: might not something more be done through legislative enactment, to insure the safety of the working miner and lessen the dangers inherent to the business? The solution of this question is everywhere beset with difficulties, but especially so with us, by reason of the peculiar conditions that prevail here; yet that much might be accomplished in this direction, through the enactment of additional laws, there is no reason to doubt.

Next to agriculture, mining, in its various departments, is the most universal industry practiced by man, and certainly the most diversified. Its practice by the different nations corresponds very nearly with their advancement in science and the civilized arts.

Both in ancient and modern times, the extent to which a nation utilizes its mineral resources has been found the truest measure of its wealth, power, and enlightenment. Those countries most distinguished for mining enterprises are also the most advanced in all the elements of true greatness.

Of such vital importance has this business been considered, that the sovereign powers in all countries where it has been largely pursued have made it the subject of laws designed for its regulation, protection, and encouragement. To this end it has been the custom to concede to the miners certain franchises, easements, and privileges, such as cutting timber on public lands, granting water privileges, tunnel sites, dumping grounds, right of way for roads, ditches, etc.; in some instances, even the the mine's taxes have been reduced or intermitted.

Among these laws passed for the benefit of the proprietor or employer, there have not been wanting provisions looking to the protection and welfare of the working miner, he having likewise been made the object of the Government's solicitude and care.

The underground life of the miner is so environed with perils, that everything consistent with reason, and not in violation of the supreme law of the land, should be done for his protection. The man who descends daily into the dark, damp workings in the bowels of the earth, to toil in vitiated air, subject to all kinds of perils, for a sum of money in no way commensurate with the risks he is taking, may well demand that the law should protect him absolutely in those matters which the foresight and knowledge of man can prevent, but which the miner has not the opportunities to investigate or remedy for himself. It is no part of his business to examine into the soundness of the timbering beyond the immediate place where he is at work, nor to explore the mine to see that foul gases are not accumulating.

The miners as a class stand forth as citizens noted for their generosity and bravery. Acts of self-sacrifice and courage occur daily among them that the world never hears of, but which prove them to be as a guild a credit to our common humanity. It is only brave, self-reliant,

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as the case may be, in charge of every coal mine, shall employ a competent and practical inside overseer, who shall keep a careful watch over the ventilating apparatus, over the air ways, the traveling ways, the pumps, and sumps, the timbering, to see, as the miners advance in their excavations, that all loose coal, slate, or rock overhead is carefully secured against falling. Over the arrangements for signalling from the bottom to the top, and from the top to the bottom of the shaft or slope, and all things connected with and appertaining to the safety of the men at work in the mine. He, or his assistants, shall examine carefully the workings of all mines generating explosive gases, every morning before the miners enter, and shall ascertain that the mine is free from danger, and the workmen shall not enter the mine until such examination has been made and reported, and the cause of danger, if any, be removed.

SEC. 6. The overseer shall see that the hoisting machinery is kept constantly in repair and ready for use, to hoist the workmen in or out of the mine.

SEC. 7. The word "owner" in this Act shall apply to lessee as well.

SEC. 8. For any injury to person or property occasioned by any violation of this Act, or any willful failure to comply with its provisions, a right of action shall accrue to the party injured for any direct damages he or she may have sustained thereby, before any Court of competent jurisdiction.

SEC. 9. For any willful failure or negligence on the part of the overseer of any coal mine, he shall be liable to conviction of misdemeanor, and punished according to law; *provided*, that if such willful failure or negligence is the cause of the death of any person, the overseer, upon conviction, shall be deemed guilty of manslaughter.

SEC. 10. All boilers used for generating steam in and about coal mines shall be kept in good order, and the owner or agent thereof shall have them examined and inspected by a competent boilermaker as often as once in three months.

SEC. 11. This Act shall not apply to opening a new coal mine.

SEC. 12. This Act shall take effect immediately.

What further laws may be required for insuring the lives, health, and safety of employés, in either our coal or quartz mines, it might be well for our Legislature to consider; also, the expediency of creating, by law, the office of a general Inspector of Mines, with such assistants as might be deemed necessary. In all the leading mining countries of Europe such an officer is provided by law, and there is ample evidence that much good has resulted from the presence of such officer.

What is termed the Mines Regulation Act, passed by the Parliament of Great Britain in 1887, provides for the framing of special rules for regulating the working of the mines in that country. Under this law, the mining rules are, in the first place, to be prepared by the owner, agent, or manager of the mine, after which they are to be so exposed for two weeks that they can be examined by the employés in the mine, who, if they find in them anything objectionable, may present the same to the Secretary of State, whose duty it is to pass on such rules, confirming, altering, or rejecting them, in whole or in part. If these rules are not objected to by the Secretary within forty days after they have been received by the District Inspector, through whom they are transmitted to him, they become established. It is not to be expected that any set of rules, however wisely drafted, will give entire satisfaction to all parties concerned; time will be required to make such alterations as experience may suggest. The objections that both employers and employed found to these rules in the beginning are disappearing under the revisions being constantly made, and much benefit has accrued to the working miner, without injury to the proprietor.

NEED OF A GEOLOGICAL SURVEY.

We are in need of a geological survey, under official guarantee of correct detail, so that capitalists abroad may have a guide to direct their investments in our direction.

We are in need of it for educational purposes—to furnish our schools with a scientific basis for instruction in natural history.

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valuable material to be there in quantity, and of the kind represented. The deposit is heavy, and the sand of as good a quality as any ever elsewhere discovered, the conditions for extracting and utilizing it being of the most favorable kind.

As a consequence, it may be stated that in a very short time, all the higher grades of glass, such as we have not heretofore been able to produce in California, will be turned out with profit and on a large scale.

That the above result is mainly due to the information obtained through the Mining Bureau, it is but just to say, this being but one of many instances in which that institution has been largely instrumental in promoting the useful industries of the State, some of which owe their very existence to information derived through the Bureau.

Very truly yours,

F. H. ROSENBAUM.

Our uncovering of these, as well as many other economic minerals, has not only lessened importation, but has aided our State financially, giving employment to many, and has retained much money within her boundaries, which otherwise would have sought other places for investment. Many of the buildings of stone, erected and being built in our State, are credited to the geological research of the Mining Bureau.

The Trustees have given much of their valuable time to the advancement of the object for which the Bureau was originated, not only to the duties for which the Board was created, but coöperated with the State Mineralogist in arranging many of the details. Although having large business interests demanding their personal attention, the Trustees were at all times ready to answer every call in the interest of the trust which they had accepted.

Mr. J. Z. Davis, President of the Board of Trustees, through unremitting donations of valuable objects of interest, has greatly enlarged our obligations.

I wish most particularly to call attention to the valuable data gathered by the Assistants in the Field; also, the masterly, comprehensive, and exhaustive special articles by several well known experts, under whose names they appear.

H. J. Willey, ex-State Surveyor-General, was engineer in charge of the Preliminary Geological and Mineralogical Map, the topographical and other work thereon being executed by Mr. Julius Henkenius, who received aid in the geological and mineralogical locatings from the Field Assistants.

San Francisco, Cal., October 4, 1890.

Hon. Wm. Irelan, Jr., *State Mineralogist:*

Dear Sir: As engineer of the State Mining Bureau, I have the honor to make the following brief report to you relative to the discharge of the duties assigned to me:

It having been your conclusion that the results of the work contemplated by you could, in many instances, best be presented to the public through the medium of a map, I have, as instructed by you, caused to be compiled from all available authentic sources a Topographical Map of this State. With this map as a basis, the several most important geological characteristics have been defined thereon in colors, and many of the metalliferous deposits indicated by symbols.

Owing to the few months of field work last year, only a small amount of information was collected by the Field Assistants which could be made use of in the compilation of the map, and much of the information obtained this year arrives too late for such use, and will have to be incorporated in the work of next year.

It has been difficult to define with exactness the various geological characteristics, and the location of the different metalliferous deposits indicated on the map by symbols. The issuance of this map by counties, and upon a larger scale, as contemplated in the future, will enable you to more accurately and perfectly delineate and indicate these characteristics. It is to be hoped, however, that the map, as completed, will serve as a valuable reference to the people and scientists, both at home and abroad, and that subsequent appropriations will enable you to issue biennially an amended and corrected map, which will always be recognized as containing authentic information, and which in time will be as complete and attractive as that of any State in the Union.

There have been many difficulties to contend with in the compilation of the Topographical Map, owing to the errors and inaccuracies of surveys, but every effort has been made to eliminate and harmonize the same as much as possible. The principal difficulty has been encountered in the efforts to define the different county boundary lines. There are so many differences between the lines as described in the statutes and the location of the lines as claimed to exist upon the ground, that it is impossible to harmonize their differences and impracticable to correctly define any of these lines upon the map. It is to be hoped that upon a proper representation of the facts with relation to these lines to the Legislature of this State, they will make provision for the revision of the statutes describing these lines, and the proper running and defining of these lines in conformity therewith.

The Preliminary Geological Map of the State represents the result of the expenditure of a very considerable amount of money. By virtue of your position as ex officio State Engineer, and the custodian of the data in that office, it has been made possible in the compilation of the Preliminary Geological Map to give the public for the first time the results of an expenditure of $100,000 of the taxpayers' money. In order to utilize the maps of the State Engineering Department, it became necessary that the great State Map should be completed, which was done, with the exception of the correction of the county boundary lines, which, for reasons heretofore mentioned, could not be correctly defined thereon.

Respectfully yours,

HARRY I. WILLEY,
Engineer.

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GEOLOGY OF THE MOTHER LODE REGION.

By Harold W. Fairbanks, B.S., Assistant in the Field.

A few words of introduction concerning the scope of this article, and of the accompanying map, may not be out of place.

The magnitude of the operations conducted on the Mother Lode gold belt since the earliest days of mining in this State, and the economic importance of a thorough knowledge of the occurrence of its ores, as well as a desire to give a scientific description of one of the most remarkable metalliferous deposits in the world, were the reasons for undertaking the field work which is the basis of this report.

The task attempted during three months in the field and two months laboratory work, was as follows: To make an examination of the lode on the surface, and trace its croppings; to enter all the open mines, where permission could be obtained, in order to get a more accurate idea of the physical characteristics of the vein; its walls, the peculiarities of ore, etc.; and, finally, to go over a strip of country four miles wide with the lode as its center; locate on township plats the various formations, in order to have data for a geological map, and also to obtain specimens of all the varieties of country rock within the limits mentioned; the specimens to be trimmed to three by four inches, and the typical ones to be investigated with the aid of the microscope.

It was hoped that a complete examination of the Mother Lode region could be made the past season, but the time proved too short for all the detailed work required. After accurately platting the lode and its inclosing rocks through Mariposa, Tuolumne, Calaveras, and Amador Counties, and simply tracing it through El Dorado County, it was found absolutely necessary to stop the field work, in order to get the report out in December, as required by law.

If provision is made, it is expected that the study of the geology of the gold belt will be continued northward, so as to include the other important mining districts of the west slope of the Sierras.

The accompanying maps have been prepared with care, and all except El Dorado County show accurately the occurrence of the inclosing rocks. In the latter county, the lode was traced through to the Middle Fork of the American River, but the inclosing rocks were only partially located. The map is given with the purpose of presenting complete the position of the lode in the five counties.

The Mother Lode may be defined as a series of gold-bearing veins of definite characteristics, and often of great magnitude, forming a nearly continuous line over one hundred miles long. They usually occur in a belt of black slate, with either slate, diorite, diabase, serpentine, or, occasionally, granite as wall rock. They are generally distinguished by a peculiar green vein-matter, known as Mariposite, and by the more or less ribbon-like character of the quartz.

As far as can be learned, the term "Mother Lode" was first applied to

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the veins worked at Nashville, twelve miles south of Placerville, El Dorado County, in the latter part of 1850, or earlier part of 1851.

In the use of the term "Mother Lode," it is not intended to convey the idea of a genetic relation to other veins or lodes. Though it is likely that, from the size, extent, and richness of this series of veins the early miners first used the expression partly with that signification, and partly, perhaps, meaning the source from whence came the great wealth of the surface placers.

The lode follows, in a general way, the northwest and southeast trend of the Sierra Nevada Mountains. The veins invariably conform to the strike of the rocks but not to the dip. The dip of the latter varies from 50 to 90 degrees, while that of the veins is from 40 to 80 degrees. In direction it ranges from north 60 degrees west to a little east of north in places. The elevation is that of the middle foothills, being as low as seven hundred feet in the river cañons. In Mariposa County it is two thousand feet, and in the northern part of El Dorado County two thousand four hundred feet.

The surface of the region traversed by the lode varies greatly: near the rivers it is cut up by deep, rocky cañons, overgrown with brush and generally quite difficult of exploration, while back some distance the country is rolling or hilly, more free from brush and more or less timbered. The topography and other physicial aspects appear in striking accord with the geologic structure. The foothill region is one which may be styled metamorphic; the more or less altered strata of the slates, schists, and sandstones being usually in excess of the eruptive rock. It is characterized by ranges of hills running parallel with the axis of the mountains, and often having between them long, deep valleys, or where the rock is of comparatively uniform hardness the hills and valleys are irregularly disposed. The distinctive surface features are not so much the result of broken, folded, or faulted strata, by which the position and trend of the valleys are partially marked out before the destructive agencies begin their action, as of a great variation in the susceptibility to erosion of the upturned edges of a single monoclinal fold.

The larger rivers flowing from the high Sierras follow a comparatively direct course to the San Joaquin Valley. At times their channels will lie for several miles in the strike of the softer strata, and when a stratum of hard crystalline rock is encountered they turn and take the shortest course through it. Their cañons are deep and narrow, with scarcely any bottom land. The tributaries of the main streams have generally cut their courses in the strike of the rocks when there exists any decided difference in the hardness of the strata.

Ordinary years this middle foothill belt is well watered. Springs are numerous, and a large part is susceptible of cultivation. Timber is quite abundant, sufficient for ordinary purposes, though material for good lumber is mostly to be found higher up. Willow or nut pine, black pine, live oak, and white and black oak are the principal trees; while manzanita, chaparral, scrub oak, greasewood, buckeye, and poison oak are the most prominent of the smaller growths.

The ascent from the plains of the San Joaquin Valley is gradual, each succeeding valley being a little higher. South of Mariposa County the slope up to the crest of the Sierras is much more rapid, and with but little intervening sedimentary strata. However, they widen quite

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abruptly in Mariposa County, and in El Dorado County they reach a width of forty or fifty miles.

The Mother Lode occupies about the center of what is called by Whitney the auriferous slate belt. The nearly level Tertiary rocks rest on the edge of the upturned slates, which are penetrated by many dikes and granite masses. The slate finally disappears and granite becomes the prevailing rock. However, it must be borne in mind that over a large part of the western slope, what is usually called a metamorphic area is formed of truly eruptive rocks, which have become so much obscured in character through various metamorphic agencies as to appear bedded and of sedimentary origin. So, also, the age of none but the Tertiary rocks has been positively decided. It is probable that the upturned slates are of Jurassic age, while the granite by which they are upturned, intruded, and metamorphosed, can hardly be considered Archaean, though it has often been mapped and described as such.

As regards the stratigraphical relation of the different members of the series as well as the paleontological evidences more will be said at the close of this report. So scanty are the fossil remains over a large part of the foothills, and so violent have been the disturbances of the strata, that the region is one of uncommon difficulty. However, within the last year, new locations of fossils have been discovered by Mr. J. D. Voy. And what is more interesting, some have been discovered in the limestone areas along the lode where hitherto all efforts in that direction have been futile.

Whatever may be the character and value of the gold deposits in Fresno County, it is certain that the Mother Lode terminates in Mariposa County. A great mass of eruptive granite extends down from the high Sierras, cuts across all the other formations, both sedimentary rocks and dikes, and terminates near Bridgeport, five miles southwest of the town of Mariposa. The dikes, as a usual thing, terminate a short distance from the granite, but the schists and slates abut against it for a distance of twenty miles, and in the vicinity of the eruptive mass they are more or less broken and metamorphosed.

The black slate stratum in which the lode lies is intercepted by the granite between Mariposa and Bridgeport, and terminates in Sec. 33, T. 5 S., R. 18 E. Near the terminus of the lode, and also in many other portions of its course, it is difficult to pick out any one vein and call it the Mother Lode in distinction from the numerous other veins in the same neighborhood.

West and southwest of Mariposa, for three or four miles, the surface is almost literally covered with float quartz, and thickly interspersed with veins. The beds of Mariposa and Stockton Creeks, Arkansas Flat, and the valleys of Carson and Agua Fria Creeks, were exceedingly rich in the early days. The mines at Mariposa, though in a somewhat different formation, have much the same character as the mines in the black slate belt, and it seems to me that they form a part of the Mother Lode system. A glance at the map on which these mineral locations are placed will show a distinctly radial or fan-shaped arrangement of the mines in this vicinity. It appears as if, when the conditions occurred for the formation of the veins, the granite formed a barrier which did not yield much to the strain in any one place, and the force spent itself in numerous cracks or small fissures; or, since the course of the veins is conformable to the inclosing rocks, we might consider the radial

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form due to a slight divergence in the strike of the schists, caused by the crowding and pushing against them of the granite mass. If, however, we confine the Mother Lode to veins occurring in the black slate, the most direct continuation of the Josephine, Mount Ophir, and Princeton Mines is in a vein cropping at intervals from the latter point southeastward, and terminating in a great exposure of quartz at the edge of the granite in the section before mentioned.

Though but two miles of country on each side of the Mother Lode was studied sufficiently for making a geological map, yet a careful examination of the succession of rocks from the plains east of Merced, nearly to the Yosemite, was made for the purpose of getting a clearer idea of the black slate formation with reference to the rest of the series. Six miles east of Merced the country begins to rise noticeably, and in the course of several miles more becomes slightly rolling and covered with those peculiar mounds and depressions known as hog wallows. Ten miles east of the town the first rock in place is met in the bank of a dry creek. It is a deposit of soft volcanic ash and tufa, with a conglomerate of large pebbles of a harder tuff and lava loosely cemented. There is quite a variety in these pebbles, many being formed of fragments of pumice and obsidian arranged in layers (1); some consist almost wholly of obsidian fragments similarly arranged (2); while others are of a trachytic nature (3 and 4), and a few are basaltic (5 and 6). A little farther on argillaceous sandstones appear. They are nearly horizontally bedded and in places contain much mica. At the base of the exposure is a conglomerate of small, well-rounded pebbles. Near the top of the sandstone, and somewhat irregularly interbedded with it, are deposits of pumiceous tufa (7). Half a mile east, on the road to Hornitos, appears a grayish volcanic rock resembling a sandstone (8). In places this varies to a fine, light-colored ash flecked with mica scales (9). Four and a half miles from Hornitos a loose granular sandstone outcrops. It consists largely of angular quartz grains, kaolinic material, and frequently large pebbles (10). It forms numerous little isolated hills, flat topped and rather precipitous on their eastern sides.

The Tertiary sandstones are succeeded by the older slate formations, on whose upturned edges they rest. The elevation at this point is four hundred and seventy-five feet. A mile east the rock is a semi-crystalline chlorite schist (11); dip to the east, but nearly vertical, strike north 30 degrees west. This is succeeded by a stratum of granulite thirty feet thick (12). Adjoining it is one of a dark siliceous rock, appearing much like a petrosilex, but containing minute grains of quartz and crystals of feldspar (13). Before reaching Hornitos the hills rise nearly nine hundred feet and show numerous dike-like masses outcroping among the slates. On the hill a mile southwest of the town there is a mass of diorite porphyrite thirty feet across. It shows a dark matrix, mottled with finely formed crystals of white feldspar, and is checked and seamed into rectangular masses (14). A few rods from this is an exposure of a similar rock which is less porphyritic, and seems to shade into the chlorite schists. Between the highly crystalline and porphyritic portions and the uncrystalline slates there could be discerned no defining line. This appearance is characteristic of many of the dike-like exposures in the vicinity of Hornitos, and more detailed examination will be needed to determine their origin. These dikes are often bunchy, but

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when of the usual form their direction corresponds to the stratification of the rocks.

Hornitos has an elevation of seven hundred and seventy-five feet. At this place, in the early days, there was considerable mining done, but the veins were pockety and uncertain in character, and now nothing is being done. Quartz veins appear with the vertical slates, and are to be seen at intervals eastward. Between Hornitos and Mount Bullion there is a large amount of good farming land. On the west, the hills are rather barren, with adobe in the valleys and gravelly soil near the plains. Specimens were gathered from a number of the most interesting dikes around Hornitos. No. 15 is diabase porphyrite, beautifully mottled with feldspar crystals. In the bed of the creek just below the town is a narrow, well defined dike, aphanitic on its edges, and coarser in the middle. A few rods above this is another of diabase, several feet in width. It is coarsely crystalline in the center (16), and nearly aphanitic at the edge (17). Adjoining this dike the slates are much metamorphosed, producing a feldspathic hornblende rock (18). No. 19 represents another very much altered dike in the same vicinity. No. 20 is a pseudo-porphyritic diorite, also altered, and containing two varieties of plagioclase feldspar. No. 21 is a knotty mica schist, produced by contact metamorphism. No. 22 is a diabase, which under the microscope appears quite fresh, and contains beautifully twined crystals of feldspar and granular augite. No. 23 is a chloritic diorite. Half a mile east is a coarse, dark rock, much decomposed, which has evidently once been a diabase or gabbro (24). In the vicinity the rocks are rather broken, and the strike varies from north 45 degrees west to east and west. The dike presents a jointed appearance, the checks running at right angles to its length, but the edges are not sharply defined.

Two miles east of Hornitos, on the toll road to Mariposa, is a dike of mica diorite (25). It has somewhat the appearance of No. 16, the mica being perhaps a secondary product. A mile east of this point is another interesting exposure in the bed of a dry creek; a narrow stratum of porphyritic diorite (26) blends off on either side, by a gradual loss of crystallization, into the soft fissile schists. The steps in this process are illustrated in specimens 27 and 28. No defining line could be discerned; but it is difficult to conceive of such a regular and thoroughly crystalline stratum inclosed in unaltered rocks without attributing to it a dike-like origin.

Jointed, slaty rocks are met with as far as the summit of the hill on the toll road, where the road passes for some distance over a coarse diabase conglomerate, in which the pebbles, in many cases, are nearly obliterated, giving the rock a homogeneous appearance (29). This is near the extreme southern point at which the diabase occurs. The rock in this vicinity has the appearance of, and was at first mistaken for, a highly metamorphic diorite conglomerate of sedimentary origin. Rounded, coarsely crystalline pebbles lie in a matrix of the same constitution, but usually darker and not so coarsely crystalline. Farther north the true character of the formation was observed, and it was proved to be of eruptive origin.

At the point where the road crosses Bear Creek, argillaceous sandstones appear, and are succeeded by the black slates of the Mother Lode. Between Hornitos and the town of Bear Valley, a very similar section is shown. Numerous porphyritic dikes occur along the road for sev-

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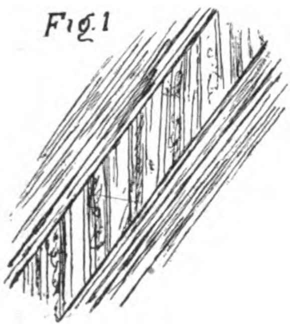
eral miles. Northeast of Hornitos they seem to be allied to the diabases, yet are often so fine grained or highly altered that their real character is difficult to determine without a microscopical examination. No. 30 is a dark, finely crystalline mica diorite, consisting largely of a brownish feldspar and minute mica scales. No. 31 is somewhat similar, but is a coarser rock, having glassy crystals of feldspar imbedded in a brownish matrix. No. 32 is from a dike-like mass formed almost wholly of hornblende in small linear crystals, and a few scattered crystals of feldspar. Occasionally, strata of mica schist slightly porphyritic are met with above Hornitos. The mica is both muscovite and biotite (33).

Between Hornitos and Bear Mountain, the slates are quite irregular in strike and dip. At the western base of the mountain one exposure shows dip 30 degrees southwest. In crossing Bear Mountain from the west, diabase conglomerate extends some distance over the summit, when sandstones and slates are met. Another section beginning at Stockton & Buffin's Ranch, and going northeast, shows about the same succession of rocks. The slates, which are often highly metamorphic, vary in strike from north 10 degrees west to north 70 degrees west, and dip 65 to 80 degrees northeast. At one place is an example of false bedding, in which certain narrow strata are crossed by lines of deposition, which make an angle with the real bedding. (Fig. 1.)

Fig. 1



No. 34 is a siliceous aphanite from the western slope of Bear Mountain. The granite which cuts across the slaty rocks of the Mother Lode south of Mariposa, has a coarse crystalline structure and consists chiefly of a white plagioclase feldspar, mica, some hornblende, and a little quartz. It decomposes easily and is characterized by a concentric or shell-like structure, which is shown very plainly in the weathering-out of rounded knobs or domes. At the northwestern extremity of this granite area, in Sec. 31, T. 5 S., R. 18 E., there is a considerable body of coarse garnetiferous hornblende rock (35). The eruptive granite does not appear on the hills west of Agua Fria Creek, and in the vicinity of Bridgeport is succeeded by a syenite of totally different character, showing a white feldspar with a tendency to the formation of elongated crystals. The hornblende also exhibits long blade-like crystals, which are often radially arranged (36). This rock continues, with some variations (37), toward the west to Moore Hill, where it is succeeded by a dark, massive mica diorite (38). Another variety is an altered diabase (39). Going westward, these are succeeded by a soft, shaly rock, which has undergone so much disturbance that the stratification is nearly obliterated. Dikes quite similar to those described occur frequently as far as the top of Moore Hill (40 and 41). The schists here contain poorly formed andalusite crystals (42), but a little way down the western slope they are in better condition, though they do not afford good specimens. The schists are very highly metamorphic in places; some are felsitic (43), while others are very siliceous (44). Between this point and the plains the rock is slaty and contains many dikes and quartz veins.

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this description that the southern portion of Mariposa County is chiefly granite, which is partly detached from that of the higher mountains by the arm of slates running southeast from Hite's Cove, while the central and northwestern portions of the county are formed largely of slaty rocks abutting at nearly right angles against the granite.

The coarse white granite at the extremity of the Mother Lode resembles very closely that of the high Sierras in the vicinity of the Yosemite and elsewhere. No. 58 is a specimen taken a little west of Mormon Bar; it contains a large amount of biotite mica, some hornblende, and a little quartz. No. 59 is from near the end of the lode and is not so friable, and contains more hornblende than the former.

The effect produced by this outburst of granite upon the adjoining slates and schists is very interesting. They are broken, twisted, and metamorphosed in the immediate vicinity, and illustrate very finely the granite contact phenomena described by Rosenbusch.

At the old mining camp of Carson, two miles west of Mariposa, the black slates strike north 48 degrees west, dipping 40 degrees northeast. Toward the south in Yaqui Gulch they gradually assume a north and south strike, and the dip varies from vertical to 70 degrees east. A mile down the gulch the dip becomes 70 degrees west, with strike a little east of north. At a distance of about a quarter of a mile from the granite, the slates begin to be slightly altered, being less fissile and having developed in them small needle-like crystals of fibrolite (60). No. 61 illustrates another phase in the metamorphism at this point, in which the needle-like crystals are very minute. The rocks resemble a dark semi-crystalline mica schist, almost aphanitic in texture. Still nearer the granite the change is into a coarser knotted mica schist (62). The next stage in the series is a mica schist more feldspathic and not so fissile, showing only a slightly knotted appearance (63). The exposure nearest the contact shows a rock nearly massive, and consisting largely of feldspar and mica, with some quartz (64). An outcrop a little west of the gulch and near the granite is that of a fine-grained mica schist (65). On Mariposa Creek, near Mormon Bar, contact phenomena are plainly shown. One mile up the creek the rock is mostly chlorite schist, strike north 65 degrees to 70 degrees west; south of the mouth of Stockton Creek and a quarter of a mile from the granite, the strike is north 45 degrees east, dip 65 degrees southeast. Between this point and the granite there is no regularity of strike or dip, and at the junction the rock loses its bedded structure and becomes massive. Wherever faint traces of stratification appear they are parallel to the boundary of the granite. The first marked change in the metamorphic process is the appearance of knotted mica schist (66). The knotted character is due partly to the development of feldspar crystals. Near the granite, the mica schist is more compact and uniform in texture (67). Next, hornblende appears as one of the prominent constituents and with it a granular feldspar.

At the junction the syenitic mass becomes seamed with feldspathic veins. The granite in turn seems to be affected by the contact, for there are irregular syenite fragments scattered through it, and there is but little mica and an excess of hornblende, while a short distance away there is only a small amount of hornblende and an excess of mica. The dividing line between the two formations is distinct, but there is not a great difference in appearance or composition.

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conditions the serpentine weathers into a honeycomb talc schist, in which the cavities are filled with oxide of iron (87). North of Mariposa, and nearly a mile from that just described, is another long, narrow area of serpentine (88). East of Agua Fria, between the slates and serpentine, there is a stratum of slate conglomerate containing pebbles of black quartz (89). The rocks which lie between the two strata of serpentine, and in which the Mariposa mines are situated, are chiefly chlorite schists, which have become semi-crystalline in places. The Mariposa vein is traceable for over two miles. It has proved very rich, especially above the town, where it is intersected by a cross vein. The main vein has a width of twenty feet in places, but the greater part of the quartz is barren, the gold occurring in pockets. It was here that Fremont's first mill was erected.

Below the town in the creek bed is another large body of quartz running more nearly east and west. A number of veins lie north of Mariposa. Their course is toward the Mother Lode, but the eruptive mass of Mount Bullion intercepts them; continuous or well defined veins being seldom met with in the crystalline rocks along the Mother Lode. Between Agua Fria and Princeton the course of the veins is north 45 degrees west; from the latter place to Mount Ophir, and a little beyond, it is north 54 degrees west, and from this point to Bear Valley north 26 degrees west, with minor variations due to the wavy course of the slates.

It has been many years since most of the mines on the Mariposa Grant have been worked, and, with the exception of the Josephine, no reliable information could be obtained concerning them. The main vein, on which the shaft of the Princeton Mine was sunk, is well defined in slate walls, and dips 70 degrees northeast. The dip of the slates is slightly more, and on the foot wall they are crumpled, producing fine parallel flutings at right angles to the dip (90).

Sandstones and some interbedded slates lie west of the black slates at Princeton. A mile to the northeast, near Mount Bullion, there is a small outcrop of limestone (91). Toward Mount Ophir there are fewer veins, but large quantities of float quartz dot the barren, bushy hills.

A small body of serpentine forms the foot wall of the vein at Mount Ophir (92). It is two hundred and twenty-five feet wide at its southern extremity, but narrows rapidly, and on Norwegian Gulch it is only a few feet across. East of it is a narrow stratum of talcose rock, rich in iron and calcite (93). This wedge shape is quite characteristic of the serpentine areas along the Mother Lode. At the upper tunnel of the Mount Ophir Mine the vein is two feet thick, and has talcose slate walls which are greatly cut up by quartz stringers, while in the lower tunnel serpentine forms the foot wall. The dip of the vein is the same as at Princeton. In the creek bed, near the old Mount Ophir Mill, the vein is very small, and for some distance north can be traced only by float quartz.

Where Norwegian Gulch opens to Bear Creek, the slates become somewhat sandy, and some distance down the creek there are fine thin-bedded conglomerates of siliceous and slaty pebbles; strike north 45 degrees west, dip 70 to 85 degrees northeast. In Green's Gulch the slates are very much broken and crumpled. A little distance east of the Mount Ophir Mill is a conglomerate formed of fragments of slate and granitic pebbles (94), which are flattened and drawn out in the stratification of the rock. Eastward up the creek, the slates show a strike only a little north of west, and gradually become more metamorphic

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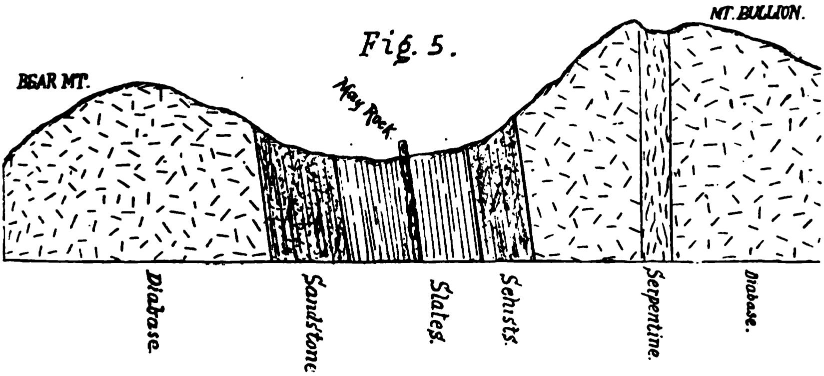
exhibits dark greenish augite crystals in a feldspathic matrix (106). A specimen from the western slope contains a brown augite in a similar matrix (107). No. 108 is a diabase at the foot of the mountain, three miles southeast of Bear Valley post office.

On the top of the northern peak is a dike of diabase porphyrite, showing light feldspar and dark augite in a green matrix (109). Near this is a fine green diabase, slightly porphyritic and giving forth a ringing sound when struck (110). No. 111 is a porphyritic diabase. No. 112 is a very fine diabase, in which the coarse variety occurs.

A conglomerate in which the pebbles are nearly obliterated, is met with for considerable distance along the serpentine at the north end of the mountain. The diabase of Bear Mountain (113) is uniform, and shows generally a conglomeritic character (114). The pebbles are small, and vary from aphanitic to coarsely crystalline, while the base in which they are imbedded is usually intermediate in texture.

Fig. 5 is a cross-section of Bear Mountain and Mount Bullion and the intervening valley, showing the May Rock, and the depression on Mount Bullion, caused by the erosion of the serpentine.



The croppings of the lode are to be seen about a quarter of a mile east of Bear Valley post office. The walls are granular talcose schists (117). Through Bear Valley the branch veins all spread southward. Toward the Josephine Mine the lode outcrops in several places, and as it approaches the serpentine, the green vein matter known as Mariposite, appears for the first time. It is associated with a white dolomitic mineral, which often contains a large amount of iron carbonate. In surface decay the iron alone remains, filling the cavities of a mass of honeycombed quartz (118).

The Josephine Mine is located on a fork in the vein. The branch on the west continues toward Coulterville, while the other can be traced less than a mile. At their point of separation on the mountain side, there is a great mass of quartz exposed, forming a swell in the foot wall fully one hundred feet thick. The veins make an angle with each other of about 8 degrees. The vein matter between them, for a considerable distance, is composed of Mariposite, ankerite, and some fragments of the wall rock. The eastern or Pine Tree vein dips at an angle of 60 degrees, which is a little less than the main one; the strike is north 24 degrees west.

The foot wall is grauwacke. The hanging wall is a coarse, feldspathic

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rock, separated from the vein by a narrow stratum of decomposed slate. It is seamed with chlorite, highly impregnated with pyrite, and though greatly altered, the feldspar still shows twining. The serpentine lies about two hundred feet east of the Pine Tree Mine. It has a width of seven hundred feet, and it is succeeded on the east by argillaceous sandstones. Near this point the diabase, which forms the northern extension of Mount Bullion, ceases (119). On the western edge of the serpentine is a stratum similar to the masses inclosed in the serpentine near Mariposa. It is a very coarse, crystalline rock, in which the former pyroxene crystals are represented by scaly masses of glistening serpentine (120). No. 121 is an amygdaloidal variety of serpentine, in which the amygdules are minute cleavable grains of calcite. No. 122 is a specimen of a massive rock from near the hanging wall of the Pine Tree vein, containing feldspar and brownish decomposed crystals of indefinite character.

The Pine Tree vein, exposed in an open cut, has a very regular body of quartz with grooved and polished surfaces (Fig. 6, Plate I). Several parallel fissures in the vein also have polished faces, showing that there has been a movement of a portion of the vein on itself, as well as on its walls. This could be rendered possible by the closing of the fissure and coating of the quartz deposited with talcose material from the walls; then if the fissure were opened again and another layer of quartz deposited, a movement of one upon the other would be comparatively easy.

The vein varies greatly in width, in places being as much as thirty feet. The hanging wall of the Josephine is massive talc, containing much calcite. The foot wall is black slate, succeeded at a little distance by grauwacke (123). The great body of quartz at the junction of the two veins has been opened partly by means of a shaft and partly by what is known as the English Trail Drift, four hundred and thirty-four feet below the croppings. This tunnel was run and a large amount of work was done before Fremont obtained the grant. A tunnel has also been run in from Benton Mills to a distance of three thousand eight hundred feet. It is one thousand three hundred feet below the croppings. The richest portion of the vein is the ribbon rock on the foot wall side. The amount of sulphurets is small. The ribbon rock consists of a succession of narrow layers of quartz and talcose or slaty material. These impart a distinctly banded structure to the vein, and seem to have favored the deposition of the metallic particles. The sulphurets and free gold are most abundant along the contact of the quartz with the talc. Outside of the ribbon rock there is usually a heavy gouge of broken quartz and slate. The quartz fills only a part of the fissure; the remainder of the vein matter being Mariposite and mixtures of calcium, iron, and magnesium carbonates. Neither is the quartz confined to any one portion of the fissure; for, in the workings of the Josephine Mine, it has been found to cross from the foot to the hanging wall side, and then to bend partly back again. A magnificent view is obtained from the croppings on the Josephine Mine (Fig. 7, Plate I). The country to the north and east is the most barren and rugged of any along the Mother Lode. It seems to be nothing but a succession of deep cañons and brush-covered hills. A reconnoissance over this section proved that it is a very difficult region in which to do geological work,

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and that the exceedingly broken surface and the remarkable variety of eruptive rock is due to intense geological disturbances.

A deep cañon, known as Hell's Hollow, lying about in the center of the slate belt, heads a little north of Bear Valley, and extends north 20 degrees west to the Merced River. On the west is a high range formed of a continuation of the Bear Mountain diabase. The serpentine crosses the Merced River just above Benton Mills, and a short distance farther north forms the hanging wall of the vein. Its width at the river is six hundred feet. It is almost wholly laminated at this point, the laminations usually running parallel with the course of the formation. Bordering the serpentine on the east is a dike of feldspar porphyry (124). Between the dike and the serpentine there is a white gouge several feet thick (125). Eastward are soft, slaty schists, and with them a narrow stratum of dark argillaceous limestone (126). A very peculiar dike of feldspar three feet wide is exposed on the river bank a little above Benton Mills. It does not form a continuous mass, a break occurring for about two feet, in which there is a body of quartz about two thirds as wide as the dike, and the slates on either side have bent in to fill up the remaining space (Fig. 8).

Fig. 8

Along the east side of Hell's Hollow the rock is chiefly grauwacke (127). North of the river the Mother Lode takes a little more westerly direction, following the river very closely; at times the river winds so as to cut across it. The serpentine continues as the hanging wall nearly to Scott's Creek. For a distance of four miles from Benton Mills the river has cut its course nearly in the strike of the rocks. It gradually changes to the north as it approaches Split Rock Ferry, and then again bends toward the west and passes out of the argillaceous sandstones (128) and slates, and across the diabase near the Anderson Mill site. Several claims have been worked on the vein east of the Crown lead. At the Jubilee Mine the vein is three feet wide, dip 40 degrees northeast. The foot wall side is the paying portion of the vein. Serpentine forms the hanging wall. Near the Merced River the slates are so much disturbed by large bodies of eruptive rock that they cannot be traced continuously. The lode is also very bunchy and irregular, and sometimes disappears altogether. The black slates disappear a little below Benton Mills, and are succeeded by grauwacke. One mile below the mills there is a split in the serpentine caused by a dike of fine white granular feldspar.

The foot wall of the lode, above Split Rock Ferry, varies from siliceous slate to a massive, siliceous aphanite (129). The lode crops out prominently on both sides of Scott's Gulch. Here the sandstones and slaty felsites have no regular strike. It varies from north 5 degrees to north 54 degrees west, often showing a wavy character. The dip is almost uniformily 68 degrees northeast. They form the body of rock for some distance up the gulch, when the black slates again appear. The vein has no well defined walls. The quartz bodies composing it are some-

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entrance of the tunnel fossils were found, the most of them being Aucellas, similar to those described by Gabb. The others are peculiar, worm-like impressions not yet determined.

Near the south end of the Adelaide is a round mass of diorite porphyrite (142). From its position this mine would seem to be located on a continuation of the Josephine vein. Its croppings are quite prominent, having a width of six feet in places. The strike is north 50 degrees west, dip 60 degrees northeast. Both walls are slate; however, it is only a short distance to the diabase on the west. On the divide, toward French Creek, the quartz veins are numerous. The continuation of the Adelaide vein is traceable most of the way to the claim owned by the Tyro Mining Company.

The slates in White's Gulch, east of the Anderson Mine, strike north 10 degrees west, dip nearly vertical. The unusual strike is caused by a great body of serpentine on the east. At the lower end of the gulch the strike is but little north of west. A little west of the head of the gulch is an area of serpentine about one thousand feet long, and between three and four hundred feet wide. Its longest extent is nearly north and south, and the strike of the slates on either hand corresponds in direction. The shaft at the Tyro Mine has opened a regular and well defined ledge. Both walls are slate, though the foot wall is the harder and more jointed. There are several inches of gouge on each side. The vein dips northeast 70 degrees, which is considerable more than that of its walls. The foot wall slates, at their contact with the vein, are bent away from the perpendicular, showing that in the movements which have taken place the foot wall has gone down. The gold is rather fine, and quite uniformly distributed. The amount of gold-bearing sulphurets, both iron and copper, is considerable, and in addition, there is a small amount of covellite, which is a copper sulphide of an indigo blue color. The vein is five feet wide and somewhat seamed, and along these seams is found the greatest amount of gold. The accompanying photograph shows the regularity of the quartz where it is exposed in the Tyro Mine (Fig. 10, Plate I). The diabase conglomerate lies only a few hundred feet to the west. On its eastern edge it is very much decomposed. The pebbles, some of which are ten or twelve inches in diameter, remain fresh; but the matrix, perhaps on account of the rock movements and some inherent weakness of structure, softens and decays (143).

A series of mines are located on the same vein north of the Tyro. The most prominent of these are the Melvina and Potosi. None of them have been worked for a number of years and data obtained was only from surface observation. The Melvina No. 1 is located on the summit of the hill between Maxwell and Black Creeks. The vein has a width of twenty feet in some places. The walls are a sandy slate. The vein as exposed in the old Potosi Tunnel is two feet thick and dips 56 degrees. The slates on Black Creek, near the old mill, are intruded by a body of diorite in such a manner as to give the appearance of a fault; but as the slates approach the diorite they lose their soft fissile character and lines of bedding and take on a black metallic luster. The creek has cut its course along the irregular junction. The metamorphic appearance of the slates indicates an eruptive origin for the diorite, which otherwise would hardly be thought possible, because of its gradual change into banded and slaty rocks outcropping a little lower down in Black Cañon. These latter appear for several hundred feet. They are sometimes highly

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siliceous and sometimes soft and shaly. West of Black Cañon diabase conglomerate is again met (144). No. 145 is a specimen of diabase porphyrite with a matrix of deep green feldspar. No. 146 is one in which there is in addition microlitic crystals of augite and a slight tendency to the separation of feldspar crystals. Farther west the rock becomes banded and schistose (147).

A short distance up Black Creek from the Potosi, thin-bedded conglomerates are met. They are formed of slate and siliceous pebbles (148). Toward Coulterville the conglomerate is succeeded by thin-bedded sandstones, strike north 25 degrees to 35 degrees west, dip 60 degrees northeast. They become more slaty, and show a greater dip nearer the town. The Malvina, or West Vein, as that part of the lode is called on which the mines just described are located, cannot be traced much more than a mile north of the Potosi. A small vein outcrops occasionally along the range of hills west of Piñon Blanco, while a spur from the latter extends southward. The hills are densely covered with brush, and no connection between the veins is traceable. The character of this vein, north of Split Rock Ferry, is somewhat different from that usually shown by the Mother Lode in Mariposa County. The gold is more evenly distributed, there are more pockets, and more sulphurets. There is no Mariposite or other vein matter, the whole fissure being filled with quartz. The great vein at Coulterville lies about a mile east, and extends parallel with the one just described. It was traced to its southern termination in Sec. 29, T. 3 S., R. 17 E. In its northern extension it continues unbroken into Tuolumne County.

It is remarkable for its immense size, in many places reaching a width of from three hundred to three hundred and fifty feet. It crosses Maxwell Creek just below Coulterville, where its width is three hundred feet. The deposits of quartz have no fixed position in the fissure, being sometimes near the hanging wall and at others near the foot wall. They are separated from each other by vein matter. The hanging wall is diorite and the foot wall is slate. On the hanging wall side, on the east bank of the creek, there is a great body of quartz ten feet thick, dip 68 degrees. This outcrop is shown in photograph (Fig. 11, Plate I).

Another large lenticular mass occurs on the west side of the creek, two hundred feet away, and about in the center of the fissure. Small irregular quartz stringers are distributed through the vein matter to the foot wall. The vein narrows somewhat in a southeasterly direction, but continues to outcrop over the hill south of town, where a large vein joins it at right angles. This can be traced two hundred yards northeast.

At the Venture Mine, a narrow strip of serpentine appears in the course of the vein and causes a split, the larger bodies of quartz and vein matter being left on the east. The vein is very bunchy and irregular, at times not showing on the surface and again appearing in prominent outcrops. Weathered portions of the vein matter have a coarse cellular structure of quartz with the cavities filled with iron oxide. The serpentine widens towards the south and forms both walls of the vein for some distance. In French Gulch, it is nearly seven hundred feet wide. Wherever the vein lies in the serpentine, it is uncommonly irregular, sometimes pinching out entirely. A dike of diorite porphyrite (149) appears on the hill, near the Venture Mine. No. 150 is a chlorite diorite from the hanging wall of this mine. East of the serpentine there is a coarse diorite poor in feldspar. The vein branches

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degrees west, dip 65 degrees northeast. Layers of a white felsite (170), from a few inches to a foot in thickness, alternate with thin bands of a dioritic rock from three to five inches wide. The latter are crossed by minute veins of calcite, which weathering out leave a series of cracks at right angles to the edges of the dikes (Fig. 12). This may have been caused by the contraction in a quickly cooled mass, the cavities being subsequently filled with calcite (171). The southern slope of Buckthorn Mountain is formed of diorite schists, which in their decomposition split up into shaly fragments. This indication of great pressure is not shown in fresh specimens. Much of the rock is intermediate between chlorite schist and a fully crystalline diorite, and it is difficult to say what was the original condition of the rock. Numbers 172, 173, and 174 are specimens taken from near the summit on the western slope. They show a somewhat altered but almost massive diorite.

A number of specimens were obtained from the serpentine south of Coulterville. No. 175 is one containing minute veinlets of chrysotile. No. 176 is a massive granular variety, with only slight traces of the original crystalline structure. Half a mile west of Coulterville serpentine appears again. It widens gradually toward Piñon Blanco, forming the hanging wall of the vein as far as the Champion Gold Mine. A little beyond this it is over one thousand feet wide. It then narrows very abruptly, and appears on the west, or foot wall side; in consequence of which the vein is broken and irregular. The serpentine hanging wall is succeeded by chlorite and talc schists (177). East of the schists there are several hundred feet of granular diorite, so decomposed that its boundaries can scarcely be determined.

The country rock for a mile and a half east of this is diorite (178) similar to that on Buckthorn Mountain, between Coulterville and Piñon Blanco; the usual vein matter predominates. There is only a small amount of quartz, and some of the way none at all. At the southern end of Piñon Blanco Quartz Claim the vein is two hundred and fifty feet wide, and shows no massive quartz. Minute quartz stringers form the network, in which appears the usual vein matter. The course of the vein is north 40 degrees west.

The serpentine in the foot wall is seven hundred and fifty feet wide. West of the serpentine is a stratum of greatly decomposed diorite, poor in feldspar (179). This is succeeded by half a mile of black slate; strike, north 30 degrees west.

The summit of the hill is formed of diabase, which extends some distance to the west (180). East of Piñon Blanco is a strip of slates inclosed in the diorite. The surface of the rock, for some distance, is so decomposed that nothing certain can be determined. North of Piñon Blanco the serpentine widens out nearly half a mile, and then contracts quite rapidly till it disappears half a mile south of Moccasin Creek. No. 181 is a specimen showing the scaly alteration product of the pyroxene. At its widest part the serpentine incloses decomposed diorite, in which there are dikes showing a considerable variety. No. 182 is serpentinous diabase. No. 183, a coarse rock composed of epidote and hornblende. No. 184 is a brownish diorite quite undecomposed. No. 185 is a granitic rock containing chlorite and feldspar.

Considerable quartz outcrops on the summit of Piñon Blanco, McAlpine, and several smaller hills. South of McAlpine, the east side of the cañon is covered with huge masses of quartz which have fallen from

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tinct bedding. From this point there is syenite for several miles along the road towards Coulterville. In the central part of Sec. 22, T. 2 S., R. 16 E., it becomes very coarse and dioritic in aspect. The hornblende is in fibrous masses, and the feldspar is somewhat glassy and of very irregular form (197). East of this and down toward the north branch of Maxwell Creek, is a hard metamorphic slate, strike east and west. In the direction of Coulterville this is succeeded by chlorite schist, which in turn is followed by diorite. No. 198 is a specimen of syenite three miles northeast of the town. There is probably but little orthoclase in this syenitic rock, but the feldspars are so clouded that they could not be distinguished by a microscopic examination.

A section from Coulterville, toward Wards, a little below the Yosemite, shows that, with but few exceptions, the rock is a more or less metamorphic schist, varying greatly in strike, dip nearly vertical. The continuation of the Hite's Cove marble appears in places. Its direction is somewhat toward the lode. Twenty-two miles above Coulterville, on the Merced River, there is a small outcrop of muscovite biotite granite (199). It is about one thousand feet across, and is surrounded by slates which are considerably altered at the contact (200). A remarkable feature of this granite is that it contains a well defined gold-bearing quartz vein of considerable richness. The slaty rocks become more siliceous up the river as far as this place. They vary from banded siliceous felsites (201) to quartz schists. East of this there is less silica in the rocks till the granite is met.

Coming back to a study of the lode on Moccasin Creek, we find that the diabase forms the high range on the west, with about three fourths of a mile of sandstone and slate between it and the lode. Scarcely any quartz is to be seen along the course of the vein for several miles toward the Tuolumne River. However, it is highly probable that the lode is continuous, for the walls are regular and well defined, and wherever the rock is well exposed the foot wall slates are broken and twisted in every direction, and present an appearance similar to that where the fissure crosses Moccasin Creek. The hanging wall, nearly to Tuolumne River, is a granite dike. The serpentine (202) widens out again on Wheeler Hill to nearly six hundred feet, and continues down the cañon about a mile, where it is interrupted by a considerable body of diorite. One mile from the river the serpentine begins again, but does not spread out so wide. The granite dike hanging wall terminates in a prominent mass about half a mile from the Tuolumne River, on the east side of Moccasin Creek. The cañon here is quite deep, the hills rising on the east to a height of over two thousand five hundred feet. A crystalline rock outcrops along the east side of Moccasin Creek, between the Culbertson place and Priests. It is so much decomposed that in many places it shows no traces of a crystalline structure. A granular decomposed diorite outcrops in the road near the hanging wall of the vein (203). No. 204 is a mica diorite from the same place. A little farther up the hill is a coarse rock of brown hornblende (205). No. 206 is a chlorite schist in which secondary mica has been developed. No. 207 is a chlorite schist with no traces of crystallization, and No. 208 is a decomposed, but still massive, diorite, from a nodule in the schists. The lamination of the schist bends around the nodules.

A diorite but little altered outcrops at Priests (209). Toward Big Oak Flat the rock becomes more micaceous, and from this place to

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siderably decomposed for some distance. Below the bridge it becomes conglomeritic, the pebbles as well as the matrix being amygdaloidal. The amygdules are also present in the compact, green diabase west of the conglomerate. In some portions the amygdules are small and dark, and the rock contains much epidote (228). In others they are large and formed of calcite (229 and 230). The texture varies from aphanitic (231) to that of a porphyrite with brown augite crystals in a green matrix (232). The lode crosses the river at an altitude of seven hundred feet. On the north bank it is fifty feet wide, strike north 65 degrees west. The hanging wall is felsite (233). The fissure is filled chiefly with Mariposite and magnesite (234). Eastward slate outcrops and at a distance of a quarter of a mile there is a deposit of limestone (235) about two hundred feet thick. Half a mile east are talcose schists and slates highly impregnated with pyrite (236); strike north 45 degrees west, dip vertical.

The second mine north of the river is the Mary Ellen. A shaft sunk on the vein shows it to be from two to six feet wide, with a gouge; the dip is 67 degrees northeast. The fissure is mostly filled with quartz containing a small amount of sulphurets. North of the Mary Ellen for some distance, the vein does not show much on the surface. The fissure is probably continuous, though serpentine and granite occur in its course. Toward Jacksonville, diabase first appears. It is sometimes fresh (237), but more often jointed and decomposed. It is succeeded by serpentine, which lies directly in the course of the vein. The serpentine is split into two arms at its northern extremity by a knob-like mass of granite.

The Willieta Gold Mine has been worked in the granite, and though there is but little quartz present, a few small stringers run in a very irregular manner through the seamed and broken portion lying in the course of the vein. A rich pocket of gold is said to have been found in the serpentine on this claim. The granite contains biotite mica, and is slightly porphyritic (238). Portions are impregnated with pyrite (239). The vein on the surface of the Clio Mine is four and one half feet thick. The hanging wall is slate. The foot wall is a decomposed, jointed rock, once crystalline. It is often seamed parallel to the vein, and in these seams there is a small amount of gouge matter. Irregular veins of quartz and calcite run through it in different directions (240). The quartz is of a solid character, and carries a small amount of sulphurets. The decomposed rock on the foot wall is five or six hundred feet wide, and extends along the river nearly to Jacksonville (241). Northward to the Republican Claim only a little quartz appears, though there is a continuous fissure with a thick gouge. The Orcutt Mine also shows but little quartz. The gouge is sometimes six feet thick, dip of fissure 40 degrees. The hanging wall is slate, the foot wall decomposed rock. The quartz on the Webster (the next claim north) is from eight to ten feet thick, and is quite massive, though on the hanging wall it is mingled with broken slate. The dip of the slates is 30 degrees, and that of the vein is much more. The slates are very much broken, and crossed by many clay seams. Small faults are numerous. The seams on the hanging wall often contain small rich pockets, and it is principally for these that the mining is carried on. Wherever the large bunches form in the vein, though they contain gold, they are too poor to pay. No. 242 is coarse diabase from the foot wall of the Webster Mine. The

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replaced by the wedge-shaped area of serpentine. It is more decomposed, and shows none of the conglomeritic character of the diabase farther south. Along its edges it is often schistose (256). About two miles and a half southeast of Chinese Camp there is a very pretty amygdaloid containing pinkish calcite (257). In this vicinity there is quite a variety of rocks, but the exposures are poor. No. 258 is a fresh diorite poor in feldspar. No. 259 is a green aphanitic diabase. No. 260 is from a vein of jasper. Traces of fragmental rocks are to be seen, and it may be that portions of the sandstone lying a little east have been inclosed in the eruptive mass (261). No. 262 is a specimen of a massive serpentine; it has a dark green body containing numerous scaly crystals. Two specimens of diabase were obtained north of Chinese Camp: No. 263 is faintly porphyritic with feldspar; No. 264 shows augite crystals in a matrix, which, in places, contains nearly blended fragments of petrosilex. No. 265 is a specimen of a granitic dike a mile south of the town.

Between Chinese Camp and Wood's Creek the diabase incloses an area a quarter of a mile wide, and of considerably greater length of slates and coarse conglomerates. The slates which lie on the west side have undergone such pressure that they show scarcely any bedding, and cleave into pencil-like fragments (266). Pebbles and large bowlders of diabase (267) are scattered through them. The conglomerate is, in some places, composed of quartz pebbles and fragments of slate (268 and 269). In others the pebbles are diorite (270). The matrix is a dark argillaceous sandstone, rendered almost crystalline (271). These coarse conglomerates present a most peculiar appearance; the components being bent and twisted out of all shape as though they had been moved while in a plastic condition. Sometimes lines of fault run through in various directions, and the parts of broken bowlders are shoved past each other. It is impossible to conceive of any such condition having resulted from water deposition, and it is probable that these rocks were caught in the eruptive mass and were partially softened and squeezed into these confused shapes. There were not seen any other conglomerates having such large bowlders or the same composition, and it is hard to account for this isolated patch.

Bordering the diorite on the east are thin-bedded conglomerates, which change into sandstone and slate toward the lode. The diorites disappear about half a mile north of Chinese Camp, and the country becomes almost level and is covered with soil, so the rock formations could hardly be traced, but it is likely that slate replaces most of the crystalline rock.

On the hill east of the lode and south of Sullivan's Creek are some fresh, dark, crystalline dikes. Sullivan's Creek crosses the vein a mile south of Poverty Hill, and here there is a very good exposure of both hanging and foot wall rock. The vein is hardly distinguishable, but is probably represented by an aggregate of small nodular masses of quartz, arranged in a parallel manner, through a stratum of talcose or chlorite schist, ten feet wide (Fig. 14). No gouge is present. West of this then are light colored talcose schists having narrow dikes interbedded with them, and which, in some instances, show peculiar contraction phenomena. One, seven inches wide, is divided into three bands; the middle one is porphyritic, and the other two are crossed by numerous crevices or cracks at right angles to the direction of the dike (Fig. 15).

Another one of these dikes is represented in Fig. 16. It is a foot wide,

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Fig. 14.

Fig. 15.

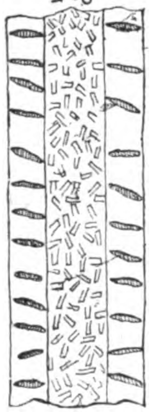


Fig. 16.

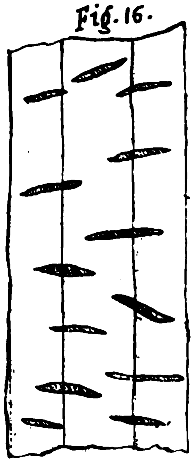
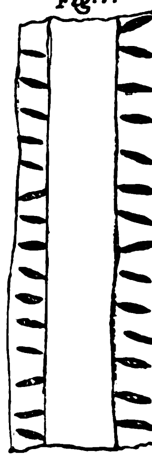


Fig. 17.



and is divided into three nearly equal bands; the checks which occur in it are more irregular than in the last. They do not often reach to the edge, and, instead of lying entirely in the outer bands, reach part way across the middle one. Fig. 17 represents a third one, eight inches wide, and also divided into three bands, the outer ones being narrow. The texture is uniform. The schists are succeeded by black, jointed slates, much contorted, and having the stratification often destroyed. They contain hard, bowlder-like masses of dark rock (272), some of which are over a foot through, and evidently of foreign material. In places they are almost numerous enough to form a conglomerate. Farther west the slates show more of their usual bedded structure, though there is no regularity.

On the east side of the vein there is about one hundred feet of hard, chloritic schist, strike north 15 degrees west. Beyond this the country rock is a chloritic felsite schist (273). A large body of quartz outcrops on the hill north of the creek. Serpentine also begins here, and widens toward the north. It lies, usually, near the foot wall. A few hundred feet north of the creek, and west of the serpentine, there is a mass of crystalline limestone. For a mile it extends in a northwesterly direction between slates and a decomposed rock (274) associated with the serpentine. Much of the slate along the west side of the limestone has been so much distorted that it crumbles into long, angular, pencil-like fragments, which lie in great bunches upon the surface.

At the Juniper Mine the East Vein is six inches thick, and is sixty feet from the main one, which has five feet of quartz. The Golden Rule Mine is quite similar to the last. The East Vein lies a hundred feet away; the amount of quartz in it is small, but the pay streak is often six feet wide. The wall rocks are slate, except the foot wall side of the main vein, which is a dike of chlorite and feldspar (275) several feet thick. There is a gouge sometimes ten inches thick. West of the dike is a stratum of serpentine; then five hundred feet of a dark, structureless rock, once crystalline (276). This is followed by the main body of serpentine, which is one thousand feet wide. The East Vein consists of

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alternate layers of quartz and chlorite, intersected by numerous little stringers. The walls are not well defined, and the amount of rock which it is profitable to work varies greatly. In the vicinity of Poverty Hill the vein is not prominent, but at Quartz Mountain, half a mile north, it expands to most remarkable proportions. The "mountain" is about six hundred feet wide, nearly half a mile long, and two hundred and fifty feet high. It is formed almost wholly of quartz and vein matter of Mariposite and ankerite. At the south end of the mountain the lode splits up into numerous little veins, which extend into the country rock and dip toward the main vein. They are not irregularly distributed, but are gathered together into lines, along which the whole mass of rock is mined and crushed. The summit of the mountain is formed of a body of quartz, about ten feet thick, which lies in the middle of the fissure. It does not extend to any great depth, for a tunnel run under it did not strike it. Another large seam of quartz lies near the west side. It dips 80 degrees northeast, and is much more continuous and well defined than the one in the middle. On the foot wall of the fissure are two dikes of feldspathic rock (277). Between them is twenty feet of serpentine.

The Knox & Boyle Mine is on the east side of the mountain, on a swell in the vein, caused by a feeder extending out a little east of north. Beautiful specimens of Mariposite are found here. No. 278 shows the surface decomposition of this mineral. Several dikes lie in the vein matter on the east side of the mountain. One is formed of granular feldspar and is richly impregnated with pyrite (279). Another is a chlorite granite seamed with calcite and feldspar (280). The Heslep Mine is located at the north end of the mountain, at a point where the vein begins to split up. On the surface it has a well defined quartz ledge in slaty walls. At some depth this solid vein is lost and there appears in its place small seams of quartz thickly massed in a slaty rock. These at times give place to flat-lying bodies of quartz. In places there is a gouge. The hanging wall at some distance below the surface is a dark micaceous felsite (281). The whole width of this rock which contains the quartz stringers is worked. This felsite often forms a horse in the vein. North of the Heslep the lode splits into two veins, fairly well defined and corresponding to the central and western bodies of quartz on the mountain. At the Dutch Claim they are about seventy feet apart. The east vein is particularly irregular, being bunchy in some places and in others breaking up into stringers, which run in every direction. It is inclosed in slate. Well defined walls are lacking, and though the fissure is continuous, yet at any one point it shows a very confused mixture of quartz bodies, slate, and stringers. No. 282 is a sample of the hanging wall. The ore carries a small amount of sulphurets. The paying portion is characterized by broken quartz mixed with a black talcose material. The west vein is more regular, dip 70 degrees northeast. Numerous small quartz seams intersect the slate between the two veins. East of Quartz Mountain the rock is a chlorite schist (283), at times pseudo-porphyritic with crystals of feldspar (284). West of the mountain there is a variety of dikes of both fresh and altered rock, with sedimentary strata. Near the base of the mountain there is an outcrop of fresh diabase (285).

A section from the Dutch Mine west to Wood's Creek shows the following succession of rocks: First, a dark altered rock like that west of the

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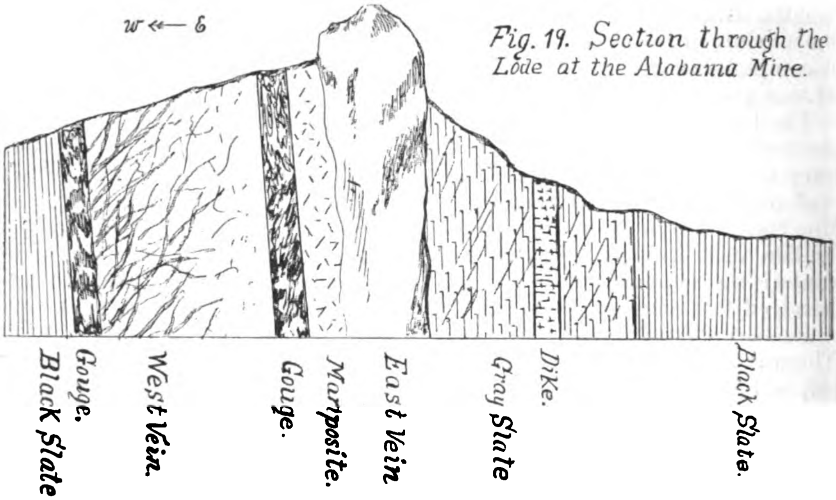

appears; dip 80 degrees. The paying portion is on the hanging wall side, where the gold is often found in graphitic slates. There is gouge on the hanging wall, and also a narrow one between it and the foot wall portion. A small amount of tetrahedrite and azurite occur in the massive quartz of the foot wall side.

A quarter of a mile east of the Trio, a vein of quartz, fifteen feet wide, outcrops by the road. Near Jamestown, on the west side of Wood's Creek, there is a hill which rises about one hundred and seventy feet, and though it shows no large seams of quartz, yet it is impregnated with mineral matter in a manner similar to that of portions of the Mother Lode. Small veins of quartz carrying gold are scattered through it, and in surface decomposition it presents an appearance very similar to that of the vein matter of the lode, excepting that there is no Mariposite. The former crystalline structure of this rock is still apparent in some places (297). The hill is over three hundred feet wide at the base, and lies in a direction north 25 degrees west. The formation is traceable southward for a considerable distance.

The rock at Jamestown is a pseudo-porphyritic schist (298). One mile north, the schists strike north 26 degrees west. Southward the strike is only 10 degrees west of north. Toward Sonora, the rock is more nearly a hydro-mica schist. A quarter of a mile west of Sonora, there is a broad porphyritic dike of micaceous diorite (299).

The quartz croppings on the hill above the Alabama Mine are quite prominent, and rise almost as high as Table Mountain. The Raw Hide Mine lies north of Table Mountain. It has not been worked for years, and the observations, as was often the case, were chiefly such as could be made above ground. The fissure is a hundred and fifty feet broad, and contains considerable bodies of quartz. A tunnel near the north end of the claim shows that the serpentine is about three hundred feet from the foot wall, which consists of a coarse serpentinous diorite. The intervening rock is a soft, jointed one, with traces of crystalline structure. Scarcely any quartz appears in the vein matter, which is about seventy feet wide. The serpentine bends a little toward the east about three hundred feet farther north, crossing the course of the vein. The vein

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matter disappears, but the fissure continues on through the serpentine. A surface crosscut on the south end of the Rappahannock discloses serpentine at a little distance on the foot wall, then a few feet of soft, jointed rock similar to that just described. This is followed by a network of small veins, in a kind of gouge material; some of these extend several feet into the adjoining rock. East of this are fifteen feet of black slate, then eight inches of gouge, followed by the serpentine hanging wall. One hundred and fifty feet farther north, in another cut, serpentine forms both walls, and the gouge is four feet thick. No quartz appears here. Two hundred feet north of this, a third crosscut shows two very small veins of quartz. The serpentine on the hanging wall is nowhere over fifty feet wide. The strike of the slates adjoining the serpentine is north 34 degrees west.

East of the Raw Hide Mine the country rock is chlorite schist, though at a distance of half a mile there are several outcrops of diabasic rock (301). The little gulch which opens toward the west from the old mill gives a good opportunity for studying the serpentine, which has a width of twenty-eight hundred feet and is quite massive. It shows several interesting features; in some places being seamed with chrysotile (302), and on its eastern side showing numerous little radial amygdule-like bodies (303). Another is a pale reddish specimen, thickly seamed with dark veinlets (304). West of the serpentine there is half a mile or more of coarse diorite (305). This is succeeded by slates. At the north end of the Rappahannock the serpentine appears only on the foot wall, and the vein expands to a width of eighty feet. It consists of vein matter of the usual kind, with the quartz mainly on the hanging wall side. The slates on the east strike north 26 degrees west. Three quarters of a mile north of the Raw Hide Mine the serpentine and the slates turn abruptly to the west. The latter have a strike from 5 degrees south of west to north 80 degrees west. The serpentine which at this point is half a mile wide, gradually tapers to a point and disappears about a mile and a half away. It is remarkable for its massive character (306). In places it contains a large amount of feldspar in which there are pseudomorphs of dark, massive serpentine after pyroxene (307). The massive character of the serpentine, at this place, indicates that the peculiar form was assumed at the time of the outburst, and was not induced by the subsequent folding of strata, for in the latter case it would have been rendered very fissile. This is interesting as giving a clew to the sequence of events in the history of these rocks. The Alameda Mine has been opened a little north of the point at which the serpentine turns. The walls are slate, and a surface crosscut shows first on the foot wall side a narrow gouge, not much more than a seam, then several feet of vein matter containing much talc, with magnesite and Mariposite. The foot wall is intersected by numerous little veins, forming a network for two feet. The ledge is from two to three feet thick. On the hanging wall are talc schists ten feet across and filled with little stringers which run down to the main body of the quartz. Some of these extend toward the east vein, which is separated by a narrow gouge. The quartz of this vein is quite irregular, and the vein matter and schists to the east are penetrated for many feet by numerous branching veins. Its dip is 65 degrees northeast, that of the slates being several degrees more. A little farther north the vein has no defining walls. It splits, and one prominent portion extending north 60 degrees west can be

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traced for a mile or more. The east vein preserves a constant direction, but grows weaker and more bunchy. For two miles the country is very bushy and it cannot be easily traced. But in the proper course it appears again a little less than a mile west of Tuttletown. The usual slaty rocks extend for nearly a mile east of the Alameda. A narrow dike outcrops a quarter of a mile east, and the slates are broken near it.

At Jeffersonville, the strike is north 64 degrees west, showing, at that distance, the effect of the displacement at the termination of the serpentine. The schists become more chloritic (308). No. 309 is one in which there is an appearance of the squeezing out of the hornblende or augite crystals and feldspar into long lamellar aggregates of chlorite. A short distance east of Jeffersonville the strike of the schist is north 15 degrees west. The country rock in the vicinity of Tuttletown is chiefly a chloritic schist, though a quarter of a mile west there is a diabase (310) undergoing decomposition, with the squeezing out of the feldspar crystals, similar to No. 309. Large veins of quartz are numerous at Tuttletown and have been worked in many places in former years. They generally correspond in direction with the Mother Lode.

Jackass Hill, north of the town, is noted for its pocket mines. Here much skill is shown by the miners in tracing up small seams and veins of quartz in search of nuggets. The lode reappears prominently on the hill north of Mormon Creek. It is about one hundred feet wide, and is composed of quartz mixed with talc, magnesite, and a little Mariposite. At this place is located what is known as the Lead Mine, so named because, years ago, a considerable amount of a native metal, having many of the properties of lead, was found. No specimens of this metal could be obtained.

The Patterson Mine lies half a mile east. It shows a prominent cropping of massive quartz without any of the Mother Lode vein matter. From this point to the Tuolumne River the vein is not at all regular; disappearing at times and again forming great bunch-like expansions. It outcrops very prominently on the Gillis & Carrington Claim, where there is a body of quartz inclosed in talcose slates, having a strike north 36 degrees west. The vein is very much broken up in the Bawn Mine (the next one north). It has no defined walls and seems to be a general mixture of magnesite, quartz (311), and talcose slates. The quartz bodies are not regular in their position, and the slates are very much twisted and broken. There is no gouge on the hanging wall, but cross-veins dip in toward the main one. These are quite pockety and carry most of the gold. Much graphite is mixed with the slates and quartz stringers. There are two irregular quartz ledges two hundred feet apart. At the north end of the claim the eastern one breaks around at right angles to its former course and joins the one on the west. The hill east of the vein is formed of an altered crystalline rock, probably a diabase. It often shows outlines of crystals (312), but in places is reduced to a chlorite schist. West for a distance of two miles the rock is slate and sandstone. Near the Stanislaus River the foot wall is chlorite slate, strike north 60 degrees west, dip 68 degrees northeast. On the hanging wall there is a felsite dike richly impregnated with pyrite (313). The vein continues irregular, and on the north side of the river, at Robinson's Ferry, it is divided into several branches. The western, or most prominent vein, is the one which has been opened by the Calaveras Consolidated Company. Near the

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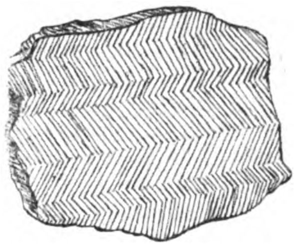
entrance to the tunnel the croppings are quite extensive. The fissure is filled with quartz and a small amount of the characteristic vein matter. A number of crosscuts in the long tunnel show, usually, a large body of massive quartz, sometimes eighteen feet thick, and dipping from vertical to 70 degrees northeast. These quartz bodies break up into aggregates of stringers for a short distance, and then again unite and form another swell. The pay rock lies on the foot wall, and varies in width from a foot to eighteen inches. It consists of light green talc and quartz, forming a ribbon rock. The sulphurets are fine and mostly confined to the talc. Portions of the vein are separated from each other by a gouge seam. For a distance of sixty feet the black slates of the hanging wall are crumpled in a very remarkable manner (Fig. 20).

Fig. 20.



Crumpled state, one tenth natural size.

They are cut by many barren veins. These finally disappear, and the crumpled walls are succeeded by slightly wavy black slates.

The foot wall slate is of a grayish color, somewhat harder and not so much crushed as that of the hanging wall. The dip of the vein is usually less than that of the slate.

The Santa Cruz Mine lies north of the Calaveras. The vein is sometimes twelve feet thick, but usually much less. The quartz in some places is very brittle and crumbly, and in others hard and compact. The pay rock is rather irregularly distributed. Near the foot wall the quartz is often beautifully stained with azurite. Ribbon rock occurs usually on the hanging wall, talc and Mariposite sometimes being mixed with it. In this mine, and also the Calaveras, the quartz is polished and striated, not only on the outside walls but between the different layers. The walls are of talc slate.

The Stanislaus Mine, which lies in gray slate, has a vein which, on the surface, is twenty inches thick, a fifteen-inch gouge on the hanging wall, and no well defined foot wall. At a depth of two hundred feet the vein breaks up into stringers.

The Adelaide is situated on a branch of the lode east of the Calaveras. The best paying portion of the vein is a stratum two feet thick on the foot wall side. The rock is largely of a ribbon character, and a movement of portions of the vein upon itself is shown by the sheet form in which the gold occurs. The vein carries Mariposite, magnesite, and a large amount of sulphurets. Graphite frequently appears in the talc seams between the quartz layers. Telluride ores are occasionally found in this mine, and also in the Keystone and Stanislaus.

The country rock east of the Adelaide Mine is chlorite schist, showing traces of crystalline structure. Robinson's Ferry has an altitude of nine hundred feet. One mile north Carson Hill rises eleven hundred feet above the ferry. It owes its existence to the union of several veins producing an enormous development of quartz, which forms the central part. On the Morgan Claim there are three nearly parallel veins, separated by some vein matter and talc slate. A section across the hill from west to east would give the following succession of strata: chlorite schists, country rock, then the Santa Cruz vein, east of which is a stratum of serpentine, followed by the Back vein of the Morgan Claim,

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at the base of the hill by diorite. No. 320 is a specimen of chloritic schist, a mile east.

About a mile and a half east of the lode, in Sec. 12, T. 2 N., R. 13 E., is a hill of syenite about half a mile in diameter. The syenite has broken through the edge of the great limestone belt on the east, and one arm of the latter reaches around to the west side. The syenite varies considerably; in places it is a very coarse hornblende rock (321), and in others it is finer and has more feldspar (322). No. 323 is a micaceous variety. West of the syenite is a fine-grained, metamorphic slate (324). The limestone varies in appearance, some being variegated (325), and some white. A peculiar dike, five inches wide, of dark aphanitic syenite, has weathered out of the limestone. It has apparently broken through the rock with great difficulty, for it is not continuous, but appears in a wavy line of almost detached, angular portions (Fig. 22).


Fig 22.

West of the syenite the slates strike north 5 degrees east. Nearer the Mother Lode the strike is north 60 degrees west. The disturbed condition of the strata, as well as their metamorphism in the vicinity of this area of crystalline rock, is proof of its eruptive origin. North of the serpentine, toward Angels, the vein becomes less prominent for a mile and a half, except at the Bruno Mine, where there is a considerable amount of calcium and magnesium carbonates (327), and some Mariposite. The vein lies in a talcose slate, and though it does not often outcrop, occasional excavations show the gouge seam. A series of little hills indicate its course as far as Angels. One mile south of the town, at Six-Mile Creek, a coarse serpentinous dike, one hundred and fifty feet wide, outcrops on the hanging wall, and continues without interruption to the town. From this place the vein becomes more pronounced and regular, quartz showing on the surface nearly all the way. The strike of the foot wall slates is north 56 degrees west. One mile southeast of Angels they strike north 70 degrees west. No. 328 is a dark aphanitic mica felsite from this section.

The Tulloch & Lane is the first mine met as one approaches the town from the south. The width is over forty feet, comprising two distinct

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follows quite closely the supposed course of the lode. Four miles northwest of Angels, near the road, there is a large amount of float quartz, and some placer mining has been done there. Some of the quartz bowlders are of great size and undoubtedly have come from a vein which outcrops east of the road, a little south of San Domingo Creek. The country rock to the east is chlorite schist. At a distance of half a mile west of the road, it gradually changes to a diorite gneiss (345), which is three fourths of a mile wide, and is followed by diabase dikes (346) and slates west of Cherokee Creek.

There are several mines between the Caliveritas and the South Fork of the Calaveras, in Sec. 4, T. 3 N., R. 12 E., and in Section 33 of the township north. Three of these, the Rathgeb, Union, and Burgess, are known as the Rathgeb Mines. The veins on which they are situated converge toward the south. The western one, the Burgess, has a large vein. The walls are not well defined, having stringers of quartz, and often a width of one hundred feet contains pay rock. The quartz is massive, and contains a considerable amount of sulphurets. The walls are of a grayish slaty rock. The hanging wall, a few hundred feet from the vein, is of diorite schist. The Union vein in some places is fifty feet wide, while the Rathgeb is from three to twenty feet wide.

The Thorp Mine is located on several small veins, lying close together, a little south of the Calaveras River. The walls are not well defined, and the mixed slate and quartz prospect for a width of fifty feet. There are several barren ledges at various distances east of the stage road, and they are occasionally met along the same course toward San Andreas. In Sec. 2, T. 3 N., R. 12 E., the rock is, to a great extent, diorite schist (347), which extends toward the Union Mine, and then turns northward and forms the line of low hills west of San Andreas. Near the Fourth Crossing the rock is a micaceous felsite schist (348), strike north 28 degrees west. A short distance west of the crossing is a dike of massive diorite conformable with the schists. Three fourths of a mile west there outcrops a broad dike of very coarse diorite (349). Toward the north the diorite is followed by a laminated serpentine, which widens out to nearly one thousand feet along the east bank of the South Fork of the Calaveras. It narrows north of the Caliveritas River, and forms the east wall of the Pioneer Chief Mine. East of the serpentine, near the mouth of the Caliveritas, there is a body of white marble (350) one thousand one hundred feet across. It extends south one third of a mile, generally lying next to the serpentine, but in places narrow strata of slate appear between them. North of the river it narrows rapidly, but outcrops occasionally for nearly a mile.

Several mines are located on an irregular vein having the serpentine as a hanging wall. The southernmost one of these is the Thorne Mine. The next, the Pioneer Chief, is remarkable for having a gouge of forty feet on the hanging wall. The foot wall is a dike of chloritic felsite (351). West of this is another dike of diabase (352) of considerable width. A dike of gabbro (353) occurs west of the serpentine at the mouth of the Caliveritas River. This strip of serpentine ceases half a mile south of the Everlasting Mine, and another narrow strip of laminated serpentine (354) begins nearly half a mile to the east. This widens northward and forms the hanging wall of the Everlasting Mine. Here the vein is very bunchy, and the gouge is heavy on both walls. A large part of the quartz has been crushed and mixed with the gouge by

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rock with very large crystals of glassy feldspar (374), talc, a bedded serpentine two hundred and twenty feet wide, a metamorphic rock formed of feldspar and bunches of chlorite (375), siliceous schists and slates, which predominate to the base of Bear Mountain, where they become very much metamorphosed (376), and some altered sandstones (377). The strike varies from north 44 degrees to 50 degrees west.

Three fourths of a mile northwest of San Andreas the serpentine is eighteen hundred feet wide. The main Mother Lode vein appears here a little within the serpentine. It is about ten feet wide with very prominent croppings, strike north 10 degrees west. One half mile down the creek the slates strike north 64 degrees west and dip 70 degrees northeast. On the top of the hill, a quarter of a mile north, the ledge is again very broad, with much Mariposite in addition to the quartz. It is traceable north of the Calaveras River and over the hill to Chili Creek, where it is about a hundred and twenty feet wide and has a direction north 46 degrees west. The amount of quartz is small and the fissure is filled mostly with Mariposite and dolemitic material. A fresh diabase dike lies on the foot wall where the Calaveras River crosses the vein, while at Chili Creek diorite forms the foot wall (378). A series of dikes extend northward to the Quaker City Mine where the foot wall is diorite (379). A dike of diabase outcrops between the two localities (380). Between Chili Creek and the Quaker City Mine the rocks are generally hidden by gravel, and though the vein cannot be traced, it is highly probable that the mine is located on it, not only from its position and the direction of the vein at both places, but also from the very heavy gouge which is characteristic of the fissure at the Quaker City as well as farther south, where serpentine forms the hanging wall. The quartz in the Quaker City varies from a few inches to four feet in width and is chiefly of a ribbon character. The gouge on the foot wall is from four to twelve inches, and on the hanging wall it is thirty feet. It is a black clay containing a large amount of quartz, usually in rounded pebbles, ranging in size from six inches to powdery grains. The crumbling, on exposure, of many of the smaller pebbles shows that they have undergone great pressure. Polished portions of the gouge have a shiny, metallic luster and contain a good deal of graphite.

A short distance south of the Quaker City there is a small outcrop of siliceous limestone. Southeast, in the middle of Sec. 36, T. 5 N., R. 11 E., there is quite an area of limestone exposed by hydraulic mining. Wherever the bedrock is exposed west of Quaker City, it is found to be slate, dark, and sometimes siliceous or feldspathic (381). In the southern part of Sec. 12, T. 4 N., R. 11 E., and about a mile west of the lode, there is a circular area of serpentine a third of a mile wide. It is chiefly fissile, and the laminæ preserve no constant direction. North of the serpentine there is an altered crystalline rock (382), probably a diorite. North and northeast of this point the surface is covered with gravel deposits nearly to the Mokelumne River. The diabase which forms the crest of Bear Mountain narrows north of the Calaveras River, and, taking a northerly direction, passes a little east of the Gwin Mine down to the Mokelumne River, where it consists of only a narrow dike, with some metamorphic strata on each side.

Near the road to Valley Springs it exhibits a schistose structure in the weathering out of flattened, lenticular masses, with sharp edges. These rise six or eight feet, and are arranged in rows with their flattened

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One mile east they vary to north 64 degrees west, then they become more siliceous and are greatly contorted, and often finely banded (409). The strike finally varies to north 80 degrees east. This is followed by a quartzite, and two miles east the rock becomes a chloritic schist; granite outcrops four miles east of Jackson.

Fig. 28

On Jackson Creek, five or six hundred feet west of town, is an irregular dike of diabase. It is not continuous, but detached masses, more or less in line, have broken through the slates, disturbing and metamorphosing them. For some distance down the creek the rock is bedded and sometimes quite slaty. The strike varies from north 15 degrees west to north 35 degrees west, with the dip 82 degrees northeast. Portions of this rock present that peculiar fragmental appearance before noticed along the edge of the diabase: angular siliceous fragments imbedded in a chloritic matrix (410), which farther west, becomes crystalline with the formation of augite crystals (411). No. 412 is a specimen showing an intermediate stage between Nos. 410 and 411, and No. 413 shows this rock changing into an aphanite. Three fourths of a mile west of town this rock is succeeded by a diabase conglomerate, very similar to that west of the lode in the three counties south. The pebbles form the greater part of the rock. Many of them are angular in general outline, but with slightly rounded corners. Others look like water-worn bowlders. (Fig. 28.)

They are arranged with their longer axes approximately parallel, and reëntrant angles are common. Some are two feet long and quite narrow, but the most of them are much smaller and more nearly round. They show a considerable variety (414). The diabase is about a mile wide, and is conglomeritic nearly the whole distance; though, toward the western side it is less distinctly so. No. 415 is a specimen of this rock two miles west of the lode. It has a pale green matrix in which augite crystals and small amygdules of calcite are imbedded. A little farther west there are slates and slaty conglomerates, strike north 15 degrees west. A section westward from the Kennedy Mine shows about the same series of rocks, except that the slaty rocks east of the diabase conglomerate are more metamorphosed, and there is a broader dike of diabase near the lode. The diabase, which forms the foot wall of the black slates, widens somewhat northward and becomes conglomeritic.

Other dikes appear between it and the diabase on the west, so that a section of the strata, exposed on Sutter Creek, shows chiefly crystalline rocks for two miles. The slate belt also widens toward Sutter Creek; half a mile south it is three hundred feet across, while at the town the width is ten hundred feet. For a distance of half a mile west of the dike, on the foot walls of the slates, there are others of great variety alternating with aphanitic and semi-crystalline schists, of which the petrosiliceous breccias form the greater part. A portion of these rocks are undoubtedly of eruptive origin. In some places the fragments of petrosilex are two inches across, and occasionally contain small, dark amygdules (416). Some portions of the diabase are altered to a feldspathic chlorite schist (417).

The most interesting of all the dikes is a diabase porphyrite (418). It contains a dark aphanitic ground mass, in which are imbedded long, well formed crystals of a light green feldspar. A conglomeritic dike contains a great variety of pebbles of aphanitic, amygdaloidal, or very coarsely crystalline diabase. The matrix also shows large calcite amygdules, and some of the augite crystals are nearly half an inch in diameter (419). In a section along Sutter Creek, east of the town, the hanging wall diabase does not appear, but instead there are several hundred feet of highly metamorphic strata, portions of which are completely crystalline. Toward the east this rock becomes a conglomerate, containing many diabase pebbles (420). Other portions are more like the breccia west of the lode. East of the metamorphic schists the rock is generally covered with gravel deposits, though there are occasional exposures of chlorite and siliceous schists, strike north 24 degrees west, dip 80 degrees northeast. A little west of the Mechanics Mine, syenite outcrops for about three hundred feet (421).

There are several mines along the lode south of Sutter Creek which have been worked to a great depth, but they have been closed for years. The Amador Consolidated has reached the greatest depth of any mine on the lode. At the 2,200-foot level a fire occurred, and the mine was closed; but it is said that the ore was as good at that level as at any in the mine.

The Wildman Mine is located at a point where the vein branches. The branching is caused by a dike, consisting almost wholly of a light-colored feldspar. At the junction the vein has a width varying from four to thirty-five feet. Portions of the horse are worked when it carries a sufficient amount of sulphurets. The gouge is twelve feet thick on the hanging wall.

The Mahoney Mine, north of the Wildman, lies on both veins. The Lincoln, which is still farther north, is located on the west or main branch of the vein. Nearly the whole surface of the Mahoney, and the southern part of the Lincoln, are cut up by small, irregular veins of quartz lying in a decomposed diabase, which forms the northern extension of the dike or horse in the Wildman Mine. The surface of the Lincoln Mine shows no large bodies of quartz, but a series of small veins covering a width of one hundred feet. At the 600-foot level these unite into one well defined ledge. On the 200-foot level there was a mass of quartz forty feet through. The gouge is sometimes on one wall, and sometimes on the other. The material mixed with the quartz in the vein is almost always decomposed rock from the hanging wall. The main ledge dips 62 degrees, and lies next to the slates, while the stringers extend off into the hanging wall in a nearly vertical direction. The best paying portion was the ribbon rock on the foot wall side at the depth where the vein had become well defined. On the hill three fourths of a mile north of Sutter Creek, a section across the lode is about as follows: On the west, six hundred feet of slate, followed by diabase; on the east, one hundred and fifty feet of diabase, seventy-five feet of slates (inclosing a small vein), a narrow dike, and slaty rocks. The main vein is inclosed in diabase for a short distance east of the North Star Mine, but in the South Spring Hill Mine and the Keystone it lies between the black slates and the diabase. The North Star Mine is located on a

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in position to that of the Cosmopolitan, but the dikes are so irregular that there can be no continuous fissure. The vein outcrops prominently above the mine, but cannot be traced far toward the west, as the veins near it run more nearly north and south. The main dike lies a little east of the Reeves Mine, and though it does not outcrop continuously is probably continuous with the one on Dry Creek and the croppings east of Plymouth. The hills between the Cosmopolitan and the New London are filled with quartz veins and dotted with prospect holes. The New London is located on one of the western veins. It is from four to fifteen feet in width and dips 60 degrees. The walls are slate and the heaviest gouge is on the foot wall. The gouge is continuous but the quartz is not. The Pacific and Empire Gold Mine is located on a vein east of the New London. A depth of fifteen hundred feet has been reached and there is no change in the character of the vein. The width varies from fifteen to sixty feet. This is partly of slate thickly intersected with quartz stringers, which have a more nearly vertical direction than the vein and extend into the hanging wall. The ore contains but little arsenical pyrites.

The black slate belt and inclosed veins turn at Plymouth and take a direction due north to the Cosumnes River and beyond. Half a mile west of the town diabase conglomerate outcrops (456). It is half a mile wide and is succeeded by a finer conglomerate, of which the components are fragments of petrosilex and rounded diabase pebbles (457). These are followed by schists for a quarter of a mile, and then by argillaceous quartzite several hundred feet thick (458). A hornblendic gneiss appears about half a mile east of Plymouth, and for two miles still preserves its gneissoid character (459). North of Plymouth the slates are again reduced to a narrow strip inclosed in dikes. A mass of diabase (460), extending from Plymouth in a direction a little west of north, is inclosed in the slates. The slates between this and the main body of the diabase strike north 24 degrees west quite regularly, but in weathering break up into slivery fragments, showing that they have been subjected to unusual pressure. There is a narrow strip of conglomerate, formed chiefly of small siliceous pebbles, between the slates and the diabase on the west. It is noticeable as far south as Drytown. At the western extremity of the inclosed diabase there is a small outcrop of variegated limestone.

A little north of Plymouth the slate belt is eight hundred feet wide, and a mile north it is six hundred feet. For many miles north and south of the town the veins in the black slates are very numerous, and though it is the custom of miners to designate the one having a diabase hanging wall and a slate foot wall the Mother Lode, it seems to me more nearly correct to apply the name collectively to the veins in the black slates.

A long, straight valley extends from Plymouth to the Cosumnes River; diabase forms the hills on the west, and those on the east are partly of diabase and partly of schists. The dike which crosses Dry Creek just east of the lode, passes through the edge of the town of Plymouth, and can be traced along the east side of Indian Creek nearly all the way to the river. Sometimes there is a vein on its western edge and sometimes the vein lies at a distance in the slates. A mile north of the town, where the creek turns northward, this diabase (461) expands to a quarter of a mile in width, and northward it is cut up into narrow dikes having

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then country rock. North of Placerville the serpentine widens to four hundred feet, lying on the east of the deep cañon which runs north to the South Fork of the American River. It is talcose on either edge. The Mother Lode outcrops nearly all the way to the river. It lies between the slates and serpentine. Other veins occur in the slate on the east side of the serpentine.

The rocks exposed along the South Fork of the American River, near the vein, and west of the black slates, are alternations of dikes and slaty, jointed rocks. East of the slates, which are a third of a mile wide, are a number of veins not showing any large bodies of quartz, but aggregations of small veins. One is in slate and several alternate with dikes. Then follow two strata of serpentine with talc between them, and east of these diorite schists for two hundred feet. The black slates in this vicinity cleave very regularly and are well adapted for roofing purposes. Two quarries have been opened.

The first mine north of the river is the Kelsey Gold and Silver Mine. No serpentine appears here, but diorite forms the east wall of the vein. Half a mile north of the Kelsey the diorite is several hundred feet wide, while a little farther north a small mass of serpentine outcrops east of the diorite. The black slates are here about half a mile wide. For two miles north of the river they pursue a course nearly north and south, then turn to the west about 25 degrees.

Dikes follow the eastern edge of the slates as far as the Guadalupe Mine, where there is a break for a mile. Between one and two miles east there is a body of serpentine, which takes a more northerly direction than the black slates, and at Georgetown it is four miles from the Mother Lode. A vein on its western side has been worked in places. From the point where this serpentine begins there seems to be a scattering of the lode. There is no continuous dike on the east side of the slates, and the veins spread and become numerous in the shists, where they are usually barren. A dike of diabase appears for a short distance along the east side of the slates north of the St. Lawrence, and as far as Garden Valley there are croppings of many veins in the slates, especially near their eastern edge. On the west are dikes similar to those in the cañon of the South Fork of the American River.

Many mines have been located between the Kelsey Mine and Garden Valley, but at present only one or two are being worked. Between Garden Valley and the Taylor Mine the main vein is all located. It lies at the eastern edge of the slates, but toward the Taylor Mine it is separated from them by diabase, which there is two hundred feet thick. East from this point to Georgetown the schists are filled with almost barren veins of quartz. The strike of the slates at the Taylor Mine is north 24 degrees west.

Northward toward the Middle Fork the Mother Lode and its formation becomes gradually less distinct. One mile north of the Taylor the diabase on the foot wall has disappeared, and a diorite schist outcrops on the hanging wall. There are occasionally large bunches of quartz in the contact.

At Graveyard Cañon the diabase again outcrops several hundred feet with the slates on the west, but the vein still lies on the east, and its position is indicated not so much by quartz as by prospect holes and surface sluicings. Half a mile north of the cañon is a small, bunchy mass of serpentine, around which a great deal of digging and

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amount, on the east side of the lode; there it forms the Mount Bullion Range, which rises four thousand two hundred and fifty feet.

Bear Mountain, of Mariposa County, and its continuation north in the high ridge west of Moccasin Creek; the Bear Mountain Range of Calaveras County; the low ridge through Amador County, and the high hills west of the North Fork of the Cosumnes River in El Dorado County, are the prominent features of this rock west of the lode. Where its surface is not too rugged, as in portions of Amador County, it produces the best of soil.

The black slates in their rapid erosion produce a light, thin soil, capable of supporting only growths of greasewood, manzanita, and chaparral, and by this growth of brush they may be traced over the greater portion of their extent. Bear Valley is perhaps one of the most fertile portions of the black slates. Its fertility is due to the wash from the diabase and the abundance of springs on Mount Bullion at the contact of the serpentine and diabase.

There is but little level land along the lode in the northern part of Mariposa County, but through the central portion of Tuolumne County the elevation is less than in Mariposa, being one thousand four hundred to one thousand five hundred feet, and there are stretches of almost level country, especially from Chinese Camp north to Table Mountain.

The portion of Calaveras County traversed by the lode is almost free from brush, for the black slates, except in the northern part of the county, are farther west. Between Angels and San Andreas there are low, undulating hills, usually covered with a good soil and having a scattered growth of nut pine and black, white, and live oak. The surface is fairly well watered by three large streams, which flow westward to the base of Bear Mountain and then turn north.

In Amador County the lode lies still lower in the foothills; elevation nine hundred to one thousand one hundred feet. The country bordering it is rolling and fertile. The cañons of Indian Creek and the North Fork of the Cosumnes River are remarkable for the large number of springs which break out along the west side of the slate belt between it and the diabase. In a distance of eight miles, the number cannot be much less than a hundred.

The course of the lode in El Dorado County is more northerly as a whole, which takes it to a much greater elevation. In places it reaches an altitude of two thousand five hundred feet. The greater part of its course south of Placerville is through a very rugged, bushy country, particularly so in the vicinity of the Church Union Mine.

Between Placerville and the South Fork of the American River, there has been a very deep cañon eroded in the black slates. Between the South and Middle Forks of the American River, the surface along the lode has an average elevation of two thousand four hundred feet, and is rolling and bushy in places along the black slates. The cañons of the Middle and South Forks of the American River are deep and narrow, but not particularly rocky.

However powerful may have been the glacial action in the high Sierras, these deep, narrow gorges indicate but a single period of rapid erosion by the agencies still at work.

Going north from Mariposa, the first trace of the old river channels in the vicinity of the Mother Lode is at Chinese Camp, where a low isolated hill just east of the town was found to be very rich. On the east

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side of Quartz Mountain there is another deposit of auriferous gravel It lies in a north and south direction.

The elevation of Table Mountain where the lode crosses it, is not more than two hundred feet above the surrounding country, and does not present as high escarpments as farther west. The erosion here has evidently not been so great as farther north, for Table Mountain is elevated but slightly, and the gravels of Quartz Mountain are below the level of the surrounding country. Another of the old river channels is indicated by a series of hills which are first seen east of Angels. It turns north of the town in the direction of San Andreas. A number of the hills are capped with a white volcanic ash, which, near Altaville, is so well consolidated that it is quarried and makes a very durable building stone. Between Altaville and San Andreas, the gravel only remains. It appears at numerous places, and several hydraulic mines are located on it. The channel passes just west of San Andreas, and probably unites with the large one south of the Mokelumne River.

The surface of the country in the vicinity of Mokelumne Hill, and eight miles westward, has been covered by an immense gravel deposit, which, looked at from the south, presents a long, gently sloping ridge, out of which rises Stockton Butte, with an elevation of twenty-five hundred feet, which is four hundred feet above the gravel ridge. The surface of the ridge is generally formed of rounded waterworn pebbles of andesitic and basaltic rocks in a matrix of fine material of much the same character. The surface of some of the lower ridges shows angular fragments. Near the bedrock the material is ash and other fine substances.

The attrition necessary to grind and polish pebbles, as they appear in portions of these beds, must have demanded an immensely protracted period, coupled with a great volume of water, for the slope of the beds is so slight that a small body of water could never have produced such effects. It is impossible to believe that they are the result of glacial action, for they never present that grooved, polished surface, or the flattening of the sides, so common in the pebbles of moraines.

Several smaller gravel ridges occur in Amador County, one being between Jackson and Sutter Creek, and another north of Sutter Creek. The surface of these ridges, as well as that of Mokelumne Hill, is very fertile.

A great ridge, several miles long, lies on the south side of Placerville. It has been cut through at one spot, and a good opportunity is presented for the study of a cross-section nearly one hundred feet in height.

THE MOTHER LODE.

In Mariposa County the lode is characterized by two veins: First, the one extending north from Princeton, through Bear Valley, along the Merced River, and constituting the west vein at Coulterville. A break occurs in this vein between the Anderson Mine and the Merced River. The other vein, beginning near the head of David's Gulch, north of the Merced River, outcrops almost continuously through Coulterville to Moccasin Creek. The fissure continues into Tuolumne County, though containing but little quartz for a number of miles. It is widest at Quartz Mountain, and here, as well as north and south for several miles, there are two veins, often lying side by side. In Calaveras County it is most prominent at Carson Hill, Angels Camp, and in the vicinity of

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Mokelumne River. Through the center of the county it is considerably scattered. Through Amador County it is nowhere confined to a single vein, but consists of a series of them, occupying a width, at times, of nearly a mile. The same condition of things exists in El Dorado County. The veins are scattered through the strip of black slates, though the main vein usually occupies the eastern edge.

Opportunity was not given for extended investigation into the mineralogical features of the lode, for the reason that such a large number of the mines are not open. Professor Silliman, in an article in the Proc. Cal. Acad. Sci., III, 380, 1867, has described several of the rarer metals, among them being tellurides of gold and silver, which are particularly abundant at Carson Hill. He also gave the name Mariposite, provisionally, to the green scaly mineral which is so characteristic of the lode. This mineral is an anhydrous silicate, containing the bases, iron, alumina, chromium, lime, magnesia, potash, silicic and carbonic acids, and traces of manganese and sulphuric acid.

A white crystalline mineral resembling dolomite is associated with the Mariposite. It consists of the carbonates of calcium, magnesium, and iron in varying proportions. The iron is generally present in large amount, forming that variety of dolomite known as ankerite, and giving rise to the red oxide so abundant in the surface decay. The iron at times may nearly or quite disappear, forming dolomite, or the calcite may be so nearly lacking that it becomes magnesite. These minerals form the great mass of the vein matter at points where the lode is so enormously expanded as at the Josephine Mine, the vicinity of Coulterville, Piñon Blanco, Quartz Mountain, Whisky Hill, Raw Hide Mine, Carson Hill, and Chili Creek.

The most interesting fact connected with these minerals as they occur in the vein, is their relation to the character of the inclosing walls. It is very rare that any vein matter is associated with the quartz when the walls of the fissure are slate, diorite, or diabase, but it is almost always present when one wall is serpentine, or when serpentine lies only a short distance away; hence, it is the most natural thing to believe that there is some relation between the walls and the vein matter. A basic rock, such as that must have been from which the serpentine was derived, undergoing decomposition, would afford opportunity for the liquids circulating through the fissure to abstract such bases as are found in Mariposite and the dolomite or ankerite, and under the proper conditions to deposit them. This had been my belief during the field work, but upon further study, in the laboratory, doubts began to arise as to the possibility of these minerals having been formed in that manner, whether such immense fissures as those demanded by the amount of vein matter could have existed. If it be urged that the space between the walls at any one time need not have been so great, and during a gradual opening the filling kept pace, then, where are the signs shown in the structure of the deposit? The vein matter is absolutely massive; there is no trace of a banded or bedded structure, and it would seem necessary that such a structure should exist, to a greater or less degree, in deposits on the walls of a fissure, either by reason of the successive additions, in which it would hardly be possible that the currents would be uniform, or the conditions the same through protracted intervals; or by successive openings and closings of the fissure, in which case more or less of the wall material would adhere to the matter deposited, and thus cause a banded appearance. This is exemplified in vein quartz, which shows a slight

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From that point a gangway was driven about one hundred feet westerly, and some two hundred and eighty feet easterly on the coal, and most of the coal above the level of this gangway was taken out, yielding, as Mr. Richards states, some one thousand seven hundred or one thousand eight hundred tons of coal. At the western end of this gangway, a shaft, or winze, was also sunk on the coal to the depth, it is said, of one hundred and seventeen feet below the gangway. Furthermore, from a point just east of where the adit tunnel strikes the coal, a slope was sunk towards the east on the coal for a distance of some sixty or seventy feet beneath the eastern gangway.

Throughout these workings the bed ranges from five to six feet in thickness, and is all clean coal. The strike here is about north 75 degrees west magnetic, and the dip 75 to 80 degrees to the north. The walls here, as well as at the "Pendaren Slope," are rather weak, and require considerable timbering. Mr. Richards states that for the one thousand seven hundred or one thousand eight hundred tons of coal which he took out from here, the cost of timbering amounted to about 12 or 13 cents per ton.

At the foot of the slope above described to the east of the tunnel, the bed shows five and one half feet of coal, which is not only clean and free from slate, but is also hard enough to require the use of powder in mining. In fact, it is the hardest coal I have yet seen in this region, and so far as can be judged from its appearance only, it would seem to be about equal in quality to the best of the Mount Diablo coals.

Altogether, this "Summit Vein" is decidedly the best and most promising of all the beds yet found in this region. A little less than half a mile to the east of the Summit Mine, a hole sunk only six or eight feet in the bed of the gulch, shows about three and one half feet of coal on what is, in all probability, the outcrop of the "Summit Vein." And nearly in the same line, in one or two of the gulches still farther east, on Section 25, probable indications of outcrop of the same bed have been also found, although no work has been done upon them.

On Section 25, there are also several other carbonaceous outcrops, which lie between the positions which should be here occupied by the "Summit Bed" and the "Eureka Bed," and which may perhaps prove to be the croppings of still other beds of coal, as yet entirely undeveloped and unprospected; but of this there is no certainty. The three beds above described are all upon which it is safe to count to-day. And even about these, there are some uncertainties.

It has been generally believed in the past that the rocks in this region were so much disturbed and faulted that the working of these coal beds would not be likely to prove profitable; and such is certainly the case at the localities where large sums of money have been vainly expended some two or three miles farther down Corral Hollow Cañon towards the east, where the rocks are exposed, and speak for themselves.

But west of Section 25, the hills are high and covered with soil, and natural exposures of the rocks are very rare, so that underground explorations alone can determine the facts as to how they lie. And it must be confessed that up to the present time such explorations are far from being sufficiently extensive to be thoroughly satisfactory. Yet, so far as they do go, they certainly point to a strong probability that the rocks in this direction are much less broken up than they are farther east, and that these beds may yet prove to be very valuable.

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the mountain, *i. e.*, far enough to reach the "Summit Bed," if it here occupies the position it should do, and thus to test far more thoroughly than has ever yet been done the real value of this coal field. The work of driving this tunnel was commenced almost immediately afterwards, and when last visited by the writer, in April, 1890, it was already in a distance of between one thousand four hundred and one thousand five hundred feet, and was rapidly advancing.

The course of the tunnel is north 36 degrees west magnetic, while the general course of the coal beds themselves, according to Mr. Newbery's survey, is about north 77 degrees west magnetic. The tunnel is driven on this oblique course (49 degrees to the west of a course at right angles to the beds, thus considerably increasing its length), for the purpose of striking the "Summit Bed" considerably farther west and beneath higher hills, where all indications point to a probability of finding the ground less disturbed and broken by faults, etc., than it is known to be among the low hills farther east.

The tunnel is a large one, being intended for a double track, which was already laid for a portion of its length. It is nine feet high by ten feet wide inside of the timbers. A considerable portion of the tunnel has hitherto stood pretty well without timber, although the rock is generally rather soft, and it may yet prove necessary to timber much more of it. Where timbering has been required so far, twelve by fourteen-inch timbers have been employed, and in such case the vertical cross-section of the tunnel is rectangular, the cap of each set of timbers, ten feet long in the clear, being supported on the under side by massive braces of the same sized timber running down to the vertical side posts on either side of the tunnel.

Something over a mile west of this tunnel, and several hundred yards southwesterly from the old Livermore Mine, Mr. Richards, in April, 1890, was engaged in sinking a new slope at a point some eight hundred or one thousand feet farther south than where the course of the "Livermore Bed" towards the west would carry it, so that unless the beds here are bent or broken, this slope must be on a new bed which underlies the "Livermore" toward the south. It goes down in a direction about north 35 degrees west magnetic, with a pitch of 34 degrees. At the time of my visit they were only down about fifty feet. and the coal was still soft and dirty, but the bed was about four feet thick at the bottom, and they were hoping to soon strike harder coal. This slope is the most westerly of all the openings yet made for coal in the Livermore region.

At this time, also, Mr. Richards was doing some work at his manganese mine in Corral Hollow Cañon, about six miles east of the long tunnel above described; but this locality was not visited.

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Within the last year a fifteen-inch pipe over three thousand feet long has been laid from the reservoir to the mine with a view of substituting water power for steam. It is estimated that it requires about forty horse-power to do the work of hoisting, and that it will require fifty inches of water delivered on the wheel to produce that power.

TALISMAN.

The work done on this mine since report of 1888 consists in a cross-cut run west through the greenstone foot wall five hundred feet long to the contact with the slate lying west of it.

From the point where the crosscut strikes this slate a drift is being run north along the line of contact to connect with the South Spring Hill works. The chief purpose of this connection is to secure better ventilation; and possibly a portion of the ore may be run out to the Talisman shaft and hoisted therefrom, thus effecting a saving of some distance in transportation.

EL DORADO

Is located on the east side of the wall of greenstone or diorite which constitutes the hanging wall of the Keystone Consolidated, and is apparently on the same vein as that which traverses the Medean and Talisman grounds.

The shaft is down about two hundred and ninety feet; the vein varies from four to six feet wide. The ore carries quite a large percentage of sulphurets, assaying from $50 to $80 per ton. The ore as far as developed is low grade (so stated), from $4 to $8.

Hanging wall is greenstone; foot wall, slate. The distance from this greenstone (hanging wall) to the same rock on the west varies from about one hundred feet at the south end of mine to four hundred feet at the north end. The outcrop of vein is continuous from end to end. There is on the mine a friction hoist with a Knight wheel, having sufficient power to hoist five hundred feet. Mine not now in operation, but is well situated for obtaining water power.

NORTH STAR.

Present depth of shaft, nine hundred and forty-two feet.

600-Foot Level.—From shaft a crosscut east to greenstone one hundred and twenty-eight feet; thence along line of contact south five hundred feet and north forty-three feet. No pay ore encountered on this level except the small body reported in 1888. There is also a crosscut run west from shaft one hundred and thirty feet. At three hundred and fifty-eight feet south of the end of first east crosscut, a second crosscut was run east twenty-eight feet, through slate mixed with stringers of quartz, to the greenstone, the hanging wall being suddenly deflected to the east here. At three hundred and eighty-eight feet in south drift run a crosscut west through slate and quartz mixed, seventy feet. At eighty feet south of end of main crosscut, a raise was made of twenty-two feet; this was the point where the small body of rich ore, referred to in report of 1888, was found, which ran through the quartz.

800-Foot Level.—Crosscut east from shaft seventy-seven feet to greenstone. South drift along contact one hundred and forty-four feet. No quartz, but in face of drift large quantities of sulphurets are showing.

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LINCOLN.

No deep work has been done on this mine since report of 1888, Mr. Stewart, the lessee, having confined his operations to the extraction of ore from near the surface. He has been, during the greater portion of the present year, running twenty stamps on ore stoped above a tunnel (adit) run on the "hanging wall vein," so called. This vein consists of alternate strata of quartz and greenstone; its strike is northwesterly and southeasterly; dip easterly at about 65 degrees from horizontal; width from eight to fourteen feet; and at the face of the tunnel, now one hundred and eighty feet from the entrance, it shows an abundance of sulphurets of a very promising appearance. The face of this drift is now about sixty feet below the surface.

West of this vein, the distance between the two lines of outcrop being from forty to sixty feet, there is another ledge, following the contact between the slate and greenstone. The croppings of this latter vein run from six to eight feet wide, showing considerable free gold and decomposed sulphurets.

From a point at the mouth of the main adit there has been run a tunnel diagonally through the greenstone a distance of fifty feet, which strikes this west vein. It is proposed to push the drift ahead on this vein after getting in somewhat farther with the main drift.

The above described bodies of ore, according to the most reliable information obtainable, were not touched by any of the former workings of this mine, and in all probability, when developed to some depth, will prove of very great value, not only in a financial sense, but as an additional proof of the frequency of occurrence and great extent of the bodies of pay ore along the line of the Mother Lode.

Ore is now conveyed to the mill over a tramway about one thousand four hundred feet long in cars having a capacity of one and a quarter tons, hauled by horses. From forty-five to fifty carloads are delivered at the mill daily, making the amount of this ore crushed by the twenty stamps from fifty-six to sixty-two tons.

PIONEER GRAVEL MINE

Is situated on the S.E. ¼ of S.W. ¼ of S.E. ¼, and S.W. ¼ of S.E. ¼ of S.E. ¼ of Sec. 4; N.W. ¼ of N.W. ¼, and W. ½ of N.E. ¼ of N.E. ¼, and N.W. ¼ of S.W. ¼ of N.E. ¼, and E. ½ of N.E. ¼ of N.W. ¼, and N.E. ¼ of S.E. ¼ of N.W. ¼, all of Sec. 9, T. 6 N., R. 11 E., M. D. M; a total of one hundred and twenty acres.

This claim covers a portion of the high gravel-capped ridge lying between the North Fork of Jackson Creek and Sutter Creek, and is located about three miles in an easterly direction from the town of Sutter Creek. The course of the ridge is south of west by north of east.

Comparatively little has been done towards the development of this property. Some years since a small amount of hydraulic work was done, the water supply being derived from the Amador Canal, which traverses the ground covered by the mine; but, so far as worked by this process, the result was not satisfactory, as nearly all the gold contained in the gravel was found within a very short distance above the bedrock.

When worked by the hydraulic process, a No. 2 Giant, throwing from one hundred and fifty to two hundred miner's inches of water (accord-

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ing to supply), under a pressure of one hundred and seventy-five feet, was used. Water was brought from the canal through eight hundred feet of eleven-inch iron pipe; four different sizes of nozzle were used. The flume was about one thousand feet long, having a grade of six inches to the box of twelve feet.

The height of the bank at the face of the hydraulic washing above referred to is about eighty feet. Beginning at the surface and going downward, about one third of the material exposed is soil, gradually becoming more mixed with sand and gravel and rounded bowlders, some of which are almost spherical, until we reach a stratum of indurated gravel seven to eight feet thick. Below this is a body of hard gray "lava cement," being from three to five feet in thickness. Immediately following is a stratum of soft "lava" of a lighter shade of gray, about ten feet thick. Next in order is a body of fine gravel and quartz sand from fifteen to eighteen feet thick. The lowest stratum of all is a compact quartz gravel carrying smooth-washed quartz bowlders. Near the bedrock it is of a bluish tinge. This last described stratum is by far the richest in the whole body; in fact, it is believed that much the larger part of all the gold lies within four or five feet of the bedrock, for which reason it would probably be more economical to drift the ground than to work it as a hydraulic mine. In view of this fact, it is now proposed by the owners to run a tunnel into the ground for the purpose of thoroughly prospecting it. This tunnel is to be started in bedrock, which is a shaly slate, some distance north, *i. e.*, below the rim of gravel deposit.

Some old claims, which were worked in early times, to the south and southwest of this property, yielded enormously; the rich gravel being found in a rather narrow channel of somewhat varying width and irregular outlines—according to the statement of men who worked in those claims.

The altitude above sea level of the crest of the ridge on which this claim is situated is about sixteen hundred feet.

WILDMAN.

The shaft is now seven hundred and twenty feet, and it is being sunk one hundred feet deeper.

From the 600-foot station in the shaft a crosscut was run west twenty feet through a body of greenstone, which constitutes the foot wall of the fissure in which the shaft was sunk. At this distance a vein thirty feet thick was encountered of fair grade milling ore carrying 1½ per cent of sulphurets, yielding from $65 to $100 per ton. They have drifted north on this vein from above crosscut fifty feet, and the ore about gave out. At sixty feet south of the crosscut the east and west veins join, at the point of the "horse," through which the crosscut was run. This vein grows smaller as it is followed south; the ore extends south from crosscut one hundred and fifty feet on this, the 600-foot level. The total distance south on 600-foot level is four hundred feet, ground requiring timbering. After passing the point of the above described "horse," the walls are slate.

On the 700-foot level a crosscut was run west, through the same body of greenstone, about the same distance to the vein, which is about twenty feet thick. A drift has been run north on this west vein fifty feet, where

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tract of land in which this vein is situated courses about four thousand feet along the ledge.

A tunnel has been run on this vein a distance of three hundred and twenty-six feet. At one hundred and fifty feet from the mouth of tunnel a crosscut was run west through alternate strata of gouge, talcose slate, and quartz, which were highly mineralized, to a dike of greenstone; also, from same starting point a second crosscut was run east from tunnel twenty-four feet through the same material and no wall found. From a point three hundred and twenty-six feet from mouth of tunnel there is being run a west crosscut in about fifty feet, encountering the same material, with more quartz than that mentioned in first crosscut. From same point (three hundred and twenty-six feet in tunnel) there has been run a crosscut east twenty-four feet in the same material without finding any wall. This body of vein matter, at every point where it has been tested, yields prospects in sulphurets and free gold.

It appears to be on the line of the eastern contact of the slate and greenstone, and apparently bears about the same relation to the east wall of greenstone that is noticed in the case of the Zeile, which is about a quarter of a mile south of this property. The whole body of ore and slate traversed by the crosscut above mentioned carried a large percentage of sulphurets and some free gold. Assays of the sulphurets showed from $80 to $140 per ton. The dike of greenstone above referred to appears to be the hanging wall of the White or Austrian Mine, hereafter described, and does not appear to extend northerly a great distance.

VOLUNTEER.

This mine is situated immediately east of and adjoining the Kennedy. A shaft has been sunk on the ledge to the depth of one hundred and sixty feet. The ledge is from two to six feet wide, a large portion of it being of rather high grade, carrying a large percentage of sulphurets; those which have been worked by the chlorination process yielded $120 per ton.

The course of ledge is northwesterly and southeasterly; dips to the east very steep. Foot wall, greenstone; hanging wall, slate.

Two levels have been opened at forty feet from surface; a drift was run north forty feet.

At one hundred and forty feet from surface a level was run from shaft fifty feet south and two hundred and fifty feet north, which was in ore the whole distance. Apparently, the foot wall is greenstone in this mine; it constitutes the hanging wall of the Kennedy. The fissure traversing this ground runs about parallel with the Kennedy fissure, and, from the outcrop, would seem to be a continuation of the Oneida; the croppings of this, the Volunteer, run up to the south boundary of the Oneida.

This mine is about one thousand one hundred feet in length along the vein. The fissure carries a large body of gouge on foot wall side.

The hoist consists of a Donnelly wheel, run under a pressure of about two hundred and fifty feet, using about thirty-five inches of water.

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After timbering the old shaft and draining the mine, it is their intention to do considerable prospecting and erect a ten-stamp mill on the ground in front of the shaft. We have no means at present of ascertaining the percentage of sulphurets contained in the ore, but they seem to be quite large. This vein is on the east line of contact; that is, it is the most easterly of all the fissure veins of the Mother Lode system, and is obviously in the same line of contact as that observed in the Zeile, Moore, and Amador Gold Mines.

The croppings along this line are traceable with scarcely a break for a distance of about five miles, being one of the most remarkably continuous and unbroken line of ore croppings in Amador County.

SARGENT.

This mine, which was mentioned in the description of the Hardenberg as a southerly extension of that mine, adjoins the Hardenberg on the south, and extends fifteen hundred feet along the same vein to the Mokelumne River. The vein throughout the entire length of the claim is well defined and strong, so far as can be determined from surface appearances. The walls are the same as those in the Hardenberg ground. There has been but very little development work done on this property—barely sufficient to meet the requirements of law. The mines are about twenty miles from timber.

THE MURRAY, VAUGHN, KRUGER, AMADOR QUEEN, AND DOYLE.

These are located along the lead which traverses the Hardenberg and Sargent, and to the north of these mines. On none of the first mentioned claims, excepting the Doyle, has there been any development work done of any consequence. Sufficient, however, has been done to determine the fact that the vein is continuous through the whole length of ground covered by these locations.

On the Doyle considerable work has been performed in the way of running drifts, *i. e.*, a main tunnel, side drifts, and crosscuts, showing a large, well defined vein of ore carrying an abundance of sulphurets. The Doyle lies immediately south of the Ætna, which is a portion of the property of the Amador Gold Mine.

All of the above mentioned properties are held under United States mineral patents, excepting the Murray, which is as yet a possessory claim.

Directly north and adjoining the ground of Amador Gold Mine is the Moore Mine, in which an incline shaft was sunk to the depth of five hundred feet on the slope, which is quite flat, being in the neighborhood of 55 degrees from the horizon. Considerable drifting was done; some ore was stoped out and milled with varying results. The vein on the 500-foot level contains rock which, judging by its appearance, should yield a profit over mining and milling expenses. No work has been done in the mine for several years. Mine owned under a United States agricultural patent.

Beginning with the Farrell Mine on the north bank of Mokelumne River, about half a mile west of the Sargent and Hardenberg Mines, hereinbefore described, we find a series of mines running northward about parallel with those situated on the eastern fissure, and maintain-

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SOUTH EUREKA.

This property embraces an area of about one hundred and forty-six acres of land covered by a United States agricultural patent, and occupies all the space intervening between the Summit and the Oneida. It is about one thousand eight hundred feet in length along the line of the lode. The northern boundary of this property is about three quarters of a mile south of the town of Sutter Creek. The course of the vein crosses the high ridge which divides the watersheds of Sutter and Jackson Creeks, attaining an elevation at its apex of about five hundred feet above Sutter Creek, where the line of the lode crosses it at an altitude above sea level of about one thousand six hundred and fifty feet. This ridge is capped with a heavy deposit of gravel, hiding the vein croppings from view, with the exception of a space of from four hundred to five hundred feet on the northern slope, which is bare of ground. Here the vein is easily traceable, the croppings of quartz and the characteristic accompanying matter, *i. e.*, black gouge, being prominent.

The only work that has been done on this ground consists of the sinking of a few prospect holes and the running of an adit tunnel near the north end, none of which reached any considerable depth below the surface.

The croppings of both the Oneida and Kennedy veins enter this ground on the south side. It is stated by the gentlemen now in possession of the property, that as soon as certain business arrangements can be perfected, it is their intention to thoroughly prospect the ground.

They contemplate using steam as the motive power for hoisting purposes, the elevation of their ground being so nearly equal to that of the only available source of water supply, that water cannot be economically used. This land is situated mainly in N.W. ¼ of Sec. 17, T. 6 N., R. 11 E., M. D. M.

GOLDEN EAGLE.

This claim is situated in S. ½ of Sec. 6, T. 6 N., R. 11 E., M. D. M. Its dimensions are eleven hundred and eight feet in length by five hundred feet in width.

Adjoining this property on the south is the Lincoln. The Golden Eagle is located on the same contact between the diorite hanging wall and the slate foot wall that runs through the Lincoln. This line, however, seems to approach nearer to the western boundary of the first named mine than to the eastern boundary. In the eastern or hanging wall diorite, some small veins of rich quartz have been found, all pitching west, that is, towards the contact. Several shafts have been sunk on the vein to depths varying from twenty to forty-five feet, when they were abandoned, either on account of the greenstone becoming so extremely hard, or for the reason that the vein diminishes to such an extent in size that it can no longer be profitably worked.

The deepest shaft sunk on this claim is located on line of contact and reaches a depth of about one hundred feet. It was found here that the greenstone pitches slightly to the west. Some strata of quartz were found in the slate near the greenstone. At the depth of one hundred feet a crosscut was driven west through the foot wall slate a distance of one hundred feet, encountering at the distance of eight feet from the shaft

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a gouge channel ten feet wide, which, from all that can be seen of it in the crosscut, stands about vertical.

The Golden Eagle is situated on the south slope and crest of the ridge dividing the western sheds of Sutter and Amador Creeks, and at its highest point is about two hundred and fifty feet above Sutter Creek, where the principal veins cross it, and about one thousand four hundred feet above sea level.

The facilities for obtaining water power are good, and the mine is easily accessible from the town of Sutter Creek.

COMET.

This mine adjoins the Golden Eagle on the north. The length of its lode line is seven hundred and twenty feet. The formation noticed in the Golden Eagle Mine continues through the Comet. A shaft was sunk on the ground to the depth of two hundred feet. No developments of any immediate importance were made. It was shown, however, by the sinking of the shaft that the fissure along the plane of contact continues to the depth attained therein, and the vein matter contained is of a favorable appearance. This shaft shows the fact that near the surface the fissure has a westerly dip, while near the bottom it dips east.

The general course of the contact and throughout this mine and the Golden Eagle is about north 20 degrees west.

BUNKER HILL.

There has been no marked developments attempted since 1888. The only work done since that year consists in stoping above the levels already run. The mill is now kept running on ore from the 700-foot level, which costs $3 20 per ton to extract.

The mill contains thirty stamps, and in place of the No. 8 screens used in 1888, they are using No. 7. In the reduction of the sulphurets they are now using about half a cord of wood per ton of sulphurets. Forty-two men are employed—eight at the mill, three at chlorination works, twenty-one at mine.

ECLIPSE GOLD MINING AND MILLING COMPANY.

The property of this company is situated in the village of Amador City, in the N.E. ¼ of Sec. 36, T. 7 N., R. 10 E., M. D. M. The claim is about nine hundred feet in length by six hundred feet wide. It is bounded on the south by the Keystone; on the east by the Spring Hill and original Amador.

The country rock throughout the whole extent of this claim is slate, as in the Keystone. This ground contains some quartz croppings which are apparently a continuation northerly of the west vein of the Keystone. A shaft was at one time sunk at the south end of the claim to the depth of one hundred and twenty feet, in vein matter, but no well defined ledge was encountered.

The property has recently been bonded for a term of five years.

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with an easterly dip (as far as can be determined from the openings) of about 65 degrees from the horizontal.

Near the south end of the claim a shaft is being sunk in the fissure, and has now reached a depth of two hundred feet. The shaft thus far has gone through a body of vein matter, *i. e.*, gouge twisted in irregular shaped masses of soft black slate and quartz bowlders, and is still in the same kinds of material. The width of the fissure where the shaft is sunk runs from four to six feet. Hoisting at this shaft is done with a friction-gear machine run by a twenty-inch Knight wheel, under a head or pressure of one hundred and eighty-five feet.

Thus far scarcely any water has been encountered in sinking. The close proximity of the Gover shaft, which is now being used by that company, affords, perhaps, a sufficient explanation of the absence of water in the North Gover; the fissure evidently continues through both veins.

PLYMOUTH CONSOLIDATED.

This is being worked through the Pacific shaft. Rock is being mined from the second and third levels, *i. e.*, from the 1,245-foot and 1,325-foot levels. In the lower level the rock is taken from north of the shaft, and in No. 2 it is taken from south of the shaft.

Water is hoisted from the south shaft at the Empire, being about twelve thousand gallons. About the same amount is hoisted from the Pacific shaft. All of the company's machinery is run by water brought through a ditch, and is delivered at mine and mill under a head of five hundred and fifty-eight feet.

Thirty stamps of the Pacific Mill are kept running on this ore.

In January, 1889, a fire occurred in the mine, breaking out between the Pacific and South Empire shafts. As a consequence, all work was suspended, and was not resumed until January of the following year. It is found that the fire did a great amount of damage, as it caused extensive caves in the ground. The fire was only extinguished by sealing up the mouths of all shafts and keeping it smothered until water arose in the mine sufficiently to reach it.

The sulphurets produced since the resumption of work have been sent to the Amador Reduction Works at Drytown.

NEW LONDON.

This mine is situated in Plymouth Mining District. Present depth of shaft, thirteen hundred and forty feet; lower level, thirteen hundred feet; south drift, five hundred and fifty feet; north drift, one hundred and fifty feet. The 1,200-foot level is in south six hundred and thirty feet; the 1,000-foot is in south six hundred feet; the 200-foot is in north one hundred and twenty feet and south one hundred and sixty feet.

Rock is being stoped from the 200, 300, 1,000, and 1,300-foot levels. With the exception of the 200-foot and 300-foot levels, in which some stoping is being done north of shaft, all of the rock now being mined is taken from the south side of shaft.

On the 1,000-foot level the ore shoot was encountered at the distance of four hundred feet south of the shaft. It has not yet been reached either in the 1,200-foot or 1,300-foot levels. The 1,000-foot level is run on the west or foot wall side of the vein, and at the extremity of the

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drift the shoot is found to still continue. Its width here, however, is not known, as it has not been crosscut.

Beginning with the point where this shoot was struck, about fifty feet of it in length was stoped out. From the south end of this stope a crosscut has been run east one hundred feet, and another vein encountered—its width not yet determined. The vein above referred to, where stoped, is about fifteen feet thick.

YELLOW JACKET

Is situated mainly in S.E. ¼ of Sec. 14, T. 7 N., R. 10 E., M. D. M. Course of vein, north 20 degrees 25 minutes west; the location, one thousand two hundred and sixty-seven feet by five hundred and seventy feet wide. A well defined line of quartz extends the entire length of the claim, with slate walls on both sides. The vein dips 70 degrees to the east.

Near the south end of the ground a tunnel has been run from west to east, entirely through slate. The tunnel, at the distance of one hundred and eighty-seven feet, cuts a ledge of quartz about three feet thick, with a black gouge on either side. The tunnel intersects the vein at a vertical depth of one hundred feet. The rock encountered here shows a small amount of free gold and a liberal percentage of sulphurets; the gouge accompanying the vein also yields sulphurets.

The heaviest croppings noticed on the claim are near the north end, where the main vein seems to be fifteen to twenty feet thick.

A shaft about twenty feet deep was sunk on these croppings, and afterwards a tunnel was started for the purpose of cutting the vein below where the shaft was located, but was abandoned after being run about forty feet.

WYOMEA.

This mine is located in the N.E. ¼ of N.W. ¼ of Sec. 2, T. 7 N., and in the S.E. ¼ of S.W. ¼ of Sec. 35, T. 8 N., R. 10 E., M. D. M. The claim is one thousand five hundred feet long by six hundred feet wide. There is a line of ore croppings, beginning about four hundred feet from the north end, and also on the center of lode line, and runs thence almost due south a distance of two hundred feet, from one to two feet in width, containing sulphurets. The walls on both sides, as far as can be determined, are greenstone.

A tunnel starting near the west boundary of the claim has been run into the greenstone, crosscutting the same a distance of one hundred and twenty feet. It is estimated that this tunnel will have to be pushed about one hundred and seventy feet farther to reach the vein, where it will be about one hundred and seventy-five feet below the surface. This tunnel is about five hundred feet south of the north end of claim.

There is observed, near the west boundary, the croppings of another vein beginning at a point one hundred feet south of the above described tunnel, and running thence into the adjoining claim on the north, *i. e.*, the Illinois. This vein averages two feet in width and carries 1 per cent of sulphurets, showing free gold by washing. Both of these veins have an easterly dip, about the same as in the other veins along the Mother Lode. Both walls are greenstone.

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feet wide. The course of vein is north and south, dipping to the east. The foot wall is greenstone, the hanging wall slate. The length of shoot cropping on surface is about two hundred feet, with an average width of from five to six feet, and in one place increases to twenty feet wide. The vein consists of two strata, separated by thin layers or seams of slate and gouge. The quartz carries some sulphurets with a little free gold. A shaft has been sunk on this vein to the depth of one hundred and ten feet, proving to that depth the vein holds its width.

CAUCASIAN.

This location is situated in Plymouth Mining District, in about the center of Sec. 23, T. 8 N., R. 10 E., M. D. M. Size of claim, one thousand five hundred feet by six hundred feet. Altitude, as per aneroid, at highest point, is one thousand one hundred and seventy-five feet. From the openings that have been made at various places the hanging or east wall seems to be greenstone, the foot wall slate. The course of vein is north and south, and its dip is toward the east at an angle of about 70 degrees from the horizontal.

Along six hundred feet of contact between the greenstone and slate, quartz croppings were found at short intervals. The average size of vein is between four and five feet.

The following work has been done on this ground, viz.: A shaft one hundred and four feet was sunk on what is apparently a spur, or offshoot of the main vein, about eighty feet east of the croppings of said vein. It is stated that this shaft produced near the surface some high grade rock. This shaft is located about three hundred and fifty feet south of the north end of the claim; it was sunk in a body of quartz and vein matter in the greenstone.

At the distance of three hundred and fifty feet south of this shaft another was sunk to the depth of eighty-five feet on the main vein, developing a well defined fissure carrying a vein of quartz about five feet thick, showing near the bottom a considerable quantity of sulphurets.

At the distance of one hundred and forty-five feet south from this point another shaft was sunk on the vein to the depth of eighty-five feet, which is now caved and entirely closed; but it is stated some favorable rock was extracted from it.

A tunnel was started at the south end of the location and run north along the fissure a distance of about five hundred feet, and throughout its entire distance was in vein matter of the fissure; but no ore shoot was encountered.

At the extreme south end of the claim about two hundred feet of pressure could be obtained from the Empire ditch for power purposes. Between three hundred and four hundred feet of pressure could be had from an extension of the Blue Lake Water Company's ditch with a pipe half a mile long.

PRIZE MINE.

This patented claim is situated on N. ½ of Sec. 26, T. 8 N., R. 10 E., M. D. M., and is one thousand five hundred feet long by six hundred feet wide. The course of vein is nearly north and south, dipping to the east. The east, or hanging wall, is greenstone. The foot wall has not yet been determined, but is thought to be slate. The width of vein is from seven

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to eight feet. The rock carries a considerable percentage of sulphurets, which, it is stated, show a fair assay value.

Four shafts have been, at different times, sunk on the claim, along a line about six hundred feet in length, on the outcrop of the vein. The deepest of these has reached a depth of eighty feet, and the others range from twenty to twenty-five feet, all sunk in quartz. Nothing is now being done on the property.

NEW HOPE.

This mine is situated one mile west of the town of Plymouth. It embraces eight acres, covered by United States agricultural patent, six hundred feet in length. Altitude of mine at shaft is one thousand two hundred feet above sea level. The course of vein is east and west, dipping north at an angle of 45 degrees, the thickness being twelve inches. Both walls are greenstone, somewhat changed, *i. e.*, partially decomposed, at surface. The vein rock is heavily charged with sulphurets (mainly arsenical), and in places rich in gold. The length of this shoot on the surface is about one hundred and fifty feet.

A shaft has been sunk on the vein to the depth of seventy-five feet, the vein holding its uniform width. Hoisting has been done by means of a "whip," that is, a rope running over a single pulley. A whim is to be substituted for this device. There is raised from the shaft two thousand three hundred gallons of water in twenty-four hours.

RED OAK.

This mine is situated in the S.E. ¼ of Sec. 11, T. 7 N., R. 10 E., M. D. M., and is one thousand five hundred feet in length by six hundred feet wide. The vein courses north and south at an altitude of one thousand and fifty feet above sea level. The angle of depression is about 70 degrees, and is from four to six feet wide. Croppings are exposed for more than half the length of the claim. The country rock through the area of the claim is slate.

The deepest shaft sunk on the mine is eighty feet. In the shaft throughout its entire depth the vein holds a uniform thickness of from five to six feet, with an accompanying clay gouge on the west side. This vein is about one thousand feet east of the New London, and running parallel with it.

SHAKESPEARE.

This claim joins the Red Oak on the south and is the southerly extension of the same vein, the croppings of which are exposed for six hundred feet on the Shakespeare ground. The altitude at highest point is one thousand and fifty feet, the lowest ground eight hundred and fifty feet above sea level. The country rock is slate. There are two veins within the boundaries of this claim; near the north end, they are two hundred feet apart, but at the south end, as far as can be determined, are about four hundred feet apart.

Very little development work has been done on this ground to determine its value or extent of deposit. Within about one hundred feet of the north end of claim a shaft has been sunk on the west vein to the depth of twenty-seven feet, showing a favorable looking vein of quartz with clay gouge from one to two feet thick on the west, or foot wall side

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of ledge. The full width of ledge is not determined by the shaft, as it is partially sunk in the foot wall, taking in only a portion of the vein.

About three hundred feet south of this shaft a crosscut tunnel has been run through the slate a distance of one hundred feet, and will probably have to be pushed fifteen or twenty feet farther to cut the vein. The tunnel is on the east side of vein. On the east vein scarcely any work has been done.

THE "49."

This patented claim is one thousand four hundred and sixty feet by six hundred feet, and is situated in the center of the E. ½ of Sec. 14, T. 7 N., R. 10 E., M. D. M.

There are two veins running through this ground with a trend north and south; the croppings are found at intervals throughout its entire length. Altitude of mine above sea level by aneroid, nine hundred feet. On the east vein, at the distance of about five hundred feet from the south end of the claim, a shaft has been sunk to the depth of thirty-seven feet, all in quartz, from four to six feet wide, and from top of shaft a tunnel was run north along the vein a distance of fifty feet, showing the vein to be of about the same width throughout its whole length.

The west vein, which is two hundred feet west of the ore above referred to, is apparently about the same size.

No openings have been made in the vein of sufficient depth to fully determine its size or regularity. A crosscut tunnel has been started east from a point near the west boundary of the claim for the purpose of cutting the west vein. This tunnel is now in about fifty feet and will have to be run fifty feet farther to reach the vein, which it will tap at a depth of about eighty feet below the surface. The country rock is slate on both sides of each of the veins.

POCAHONTAS.

This patented claim is thirteen hundred and fifty-six feet in length by an average of five hundred feet wide, and is situated partly in the N.E. ¼ of Sec. 23, and partly in the N.W. ¼ of Sec. 24, T. 7 N., R. 10 E., M. D. M.

The country rock throughout the whole of the claim is slate, trending north 20 degrees west. The croppings of one of the veins can be seen throughout the entire length of location and are bold and strongly marked, ranging from six to twenty-five feet wide. Only a small amount of development work has been done on these veins. A tunnel was started south on the west vein at a distance of about two hundred and fifty feet south of the north end of the claim and driven fifteen feet. Eighty feet north a shaft was sunk to the depth of sixty feet on the west or foot wall side of the vein, the vein on the surface being twenty feet wide. About sixty feet east of this shaft another was sunk to the depth of eighty feet on a vein which runs parallel with that above referred to. This shaft was sunk by the owners of the ground adjoining on the east, and it is stated that an extremely fine body of quartz was developed. The outcrop of this, the second vein, can only be traced a short distance. North of this shaft the vein seems to pass into the California ground. The east vein contains a high percentage of sulphurets. Both of these veins have an easterly dip. The location is bounded on the north by

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BUTTE COUNTY.

By J. A. Miner, Assistant in the Field.

This county, formerly a large producer of gold, has, within the past few years, been less prominent in that direction on account of the restriction placed on hydraulic mining, which was largely the source from whence the supply was obtained. Within the past few months, however, greater activity is noticeable throughout the entire mining sections, both in drift as well as in vein mining. New developments with flattering prospects are being made in the northeastern portion of the county, where a large extent of mining ground is yet undeveloped, which from past evidences, is believed to contain many miles of ancient river channels, capable of being worked by the drifting process.

THE BIG BEND TUNNEL.

This enterprise has been fully described in former reports. It is said that nothing will be done during the present season in the way of working the bed of the Feather River, where drained by the tunnel, but the water will be conveyed from the tunnel to the town of Oroville and the adjacent country, to supply power for manufacturing purposes, and for irrigation.

SPRING VALLEY HYDRAULIC GOLD MINE.

This mine is located at Cherokee, in T. 20 and 21 N., R. 4 E., M. D. M., in Secs. 4, 5, 28, 29, 32, 33, and consists of about one thousand five hundred acres. About one hundred and fifty acres of this area have been worked from surface to bedrock about five hundred feet in depth, while a like area has been worked from the top down to within fifteen feet of the bedrock. These last fifteen feet in depth are composed of cemented gravel and bowlders, requiring blasting before washing. A portion of this latter ground has been leased to some Portuguese, while another portion is to be worked by mill process, for which purpose the necessary works are in course of construction, at an outlay of at least $10,000. The litigation in regard to working this mine by hydraulic process having been compromised, the Superintendent states that after the first of October, 1890, that method of working will be discontinued. The possibility of working this gravel deposit in the future by drifting is not considered feasible.

When located	1854.
Name of nearest town	Cherokee.
Elevation of nearest town	1,221 feet.
Direction and distance from town	West, one fourth mile.
Size of claim	1,500 acres.
Source of supplies	Oroville.
Distance from nearest railroad station	12 miles.
Cost of freight from railroad station to mine	25 cents per 100 pounds.
Cost of freight from San Francisco to railroad station	82 cents per 100 pounds.
Capping	Lava.

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Cost of freight from railroad station to mine	$15 per ton.
Cost of freight from San Francisco to railroad station	$9 per ton.
Size of claim	160 acres.
Class of deposit	Ancient river.
Capping	Lava.
Gravel, in feet	20 feet.
Course of channel	East of north and west of south.
Elevation of top of deposit above level of sea	2,420 feet.
Elevation of underlying rock	2,400 feet.
Elevation of nearest ravine	Small ravine, 2,400 feet.
Class of bedrock	Serpentine.
Worked by shaft or tunnel	Tunnel.
Cost of tunnel per foot, including track	$9.
How ventilated	By two tunnels.
Kind of drill used	California rock drill.
Kind of powder used	Giant No. 2.
Kind of gravel	Cemented.
Manner of recovering gold	Washing.
Width of channel drifts	300 feet.
Depth of gravel drifts	5 feet.
Percentage of cobbles and bowlders	66 per cent.
Number of shifts per day	2.
Number of men per shift	5.
Weight of carload of gravel	1 ton.
Kind of timber used	Spruce and cedar.
Source of supply	On claim.
Kind of lumber	Spruce.
Source of supply of lumber	Chico.
Distance to supply of lumber	22 miles.
Cost of lumber as measured	$30 per thousand.
Source of supply of water	Springs.
Length of water season	Continuous.
Number of men in mine	12.
Number of men on outside work	4.
Total men employed by company	16.
Average wages paid per day	$2.
Length of channel worked	300 feet.

PETER WOOD'S MINE.

Located in Forks of Butte Mining District, on Sec. 26, T. 24 N., R. 3 E., and contains one hundred and sixty acres. It has been worked from face of the mountain for a distance of seventy-five feet by two hundred and fifty feet, by hydraulic process. At this point a tunnel has been driven in eight hundred feet on an easterly course. North of this about eight hundred feet a second tunnel has been driven on the same course for seven hundred feet. Again, sixteen feet under the last mentioned, a third tunnel has penetrated two hundred feet. The 800-foot tunnel is timbered for a distance of one hundred and twenty-five feet; the rest is run in bedrock, which is slate. The vertical depth from face of the 700-foot level to surface is three hundred feet. From the 200-foot tunnel an upraise to the 700-foot connects the two and furnishes ventilation. Most of the stoping has been done near the breast on this 700-foot level.

The gravel in this mine is of a twofold character: Blue, mixed with medium sized white washed gravel, and brown or iron stained gravel, but little washed, and intermixed with sand and some sediment. The blue gravel is producing very handsome returns, the gold being generally coarse; the largest piece taken out was worth $70. For washing the gravel, water is obtained from Little Butte Creek and conveyed in a ditch one and one half miles in length. The ditch carries fifty inches, and delivers under a thirty-foot head.

When located	1865.
Name of nearest town	Lovelock.
Elevation of nearest town	3,150 feet.

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Direction and distance from town	West, 3 miles.
Distance from the nearest railroad station	22 miles.
Size of claim	160 acres.
Class of deposit	Ancient river.
Capping	Lava.
Depth of deposit, lava	300 feet.
Depth of deposit, soil	4 feet.
Depth of deposit, gravel	20 feet.
Course of channel	Northeast and southwest.
Class of bedrock	Slate.
Worked by tunnel or shaft	Tunnel.
Cost of tunnel, including track, per foot	$8.
How ventilated	By upraise between tunnels.
Kind of drill used	Hand drill.
Kind of powder used	Giant No. 2.
Kind of gravel	Free.
Method of recovering gold	Washing.
Width of channel drift	Narrow.
Depth of gravel	4 feet to 5 feet.
Percentage of cobbles and bowlders	33 per cent.
Number of shifts per day	1.
Number of men per shift	5.
Weight of carload of gravel	1 ton.
Total cost of recovery of gold per carload	50 cents.
Quantity of water used for washing	50 inches.
Kind of timber used	Spruce and cedar.
Source of supply	On claim.
Cost of timber as measured	4 cents per foot.
Kind of lumber	Yellow pine and spruce.
Source of supply	Hupp's Mill.
Distance to mill	2½ miles.
Cost of, as measured	$15 per thousand.
Length of water season	All the year.
Number of men employed	5.
Average wages paid per day	$2.
Length of channel worked	Nominal.

ALKI OR PARRY.

Located on west branch of Feather River, in Lovelock Mining District, on Sec. 18, T. 23 N., R. 4 E., M. D. M., and claiming seven hundred acres. From the developments made it would seem as if this property will disclose the largest drift channel yet found in Butte County, and the three owners, who have made all the developments within themselves, are deserving of great praise for the energy and perseverance shown. The depth of the deposit is as yet unknown. The mine has been opened by an incline shaft having a pitch of about one third, which starts near the bed of the west branch of the Feather River, passing first through a hornblende and slate bedrock for a distance of seventy-five feet, then into gravel for fifty feet; the shaft then straightens up for eighteen feet, when it once more assumes the former pitch until it reaches bedrock at a distance of two hundred and thirty-five feet. This is supposed to be the bottom or level of the main channel, and a drift is run from here two hundred feet, following the bedrock among large washed bowlders and coarse granitic sand. At several points on the incline drifts have been started and some gold found, but not in paying quantities. The channel produces eight miner's inches of water, which is drawn from the mine by a Hooker pump operated by a sixteen-foot waterwheel with four-foot breast, which receives its water from a ditch one quarter of a mile long, heading in the west branch of the Feather River, and with a capacity of three hundred miner's inches. The hoisting is done on the car through the incline.

Name of district	Lovelock.
When located	1886.
Name of nearest town	Magalia.

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Name of nearest town	Lovelock.
Elevation of nearest town	3,150 feet.
Direction and distance from nearest town	Northeast, 15 miles.
Distance from nearest railroad station	30 miles to Chico.
Cost of freight from railroad station to mine	1½ cents per pound.
Cost of freight from San Francisco to railroad station	$8 per ton.
Size of claims	180 acres and 160 acres.
Class of deposit	Ancient river.
Capping	Lava.
Depth of deposit, lava	100 feet to 150 feet.
Depth of deposit, gravel	2 feet to 15 feet.
Course of channel	Northeast and southwest.
Elevation of top of deposit above sea level	5,250 feet.
Elevation of underlying rock	5,125 feet.
Nature of bedrock	Granite.
Worked by tunnel or shaft	Tunnel.
Cost of tunnel, per foot, including track	$2 25.
Kind of drill used	Hand drill, ⅜-inch steel.
Kind of powder used	Giant Nos. 1 and 2.
Nature of gravel	Free.
Gold recovered	In sluice.
Width of channel drifts	50 feet to 200 feet.
Depth of gravel drifts	6 feet.
Percentage of cobbles and bowlders	20 per cent.
Number of shifts per day	2.
Number of men per shift, combined	8.
Fineness and value of gold	907 fine; $18 37.
Quantity of water used in washing	60 inches.
Quantity of water used in sluicing	100 to 150 inches.
Kind of timber used	Pine, fir, cedar, sugar pine.
Source of supply for timber	On claim.
Cost of timber	2 cents per foot.
Kind of lumber	Sugar and yellow pine.
Source of supply for lumber	Doon's Mill.
Distance to sawmill	12 miles.
Cost of lumber	$27 per thousand.
Source of water supply	Big Kimshew Creek.
Cost of water	Company's own ditch.
Length of ditch	3 miles.
Head of water, in feet	100 to 150 feet.
Length of water season	6 to 8 months.
Number of men employed, combined	16.
Average wages per month	White men, $40 and board; Chinamen, $20 to $25 and board.
Length of channel worked, combined	800 feet.

BUTTE STAR.

This property is better known as the Cole Mine. It is located about one and one half miles west of Nimshew, on the south side of Big Butte Creek, in Helltown Mining District, on Sec. 22, T. 23 N., R. 3 E., M. D. M. A bedrock tunnel six hundred feet in length was run to gravel, and the tunnel was continued for two thousand four hundred feet. The course of the channel is E. of N. 10 degrees; stoping has been done for a distance of two thousand four hundred feet. The mine is being worked under lease, and the lessees are rather reticent.

When located	1851.
Name of nearest town	Nimshew.
Elevation	2,470 feet.
Direction and distance from nearest town	West, 1½ miles.
Class of deposit	Ancient river.
Capping	Lava.
Depth of deposit, lava	800 feet.
Depth of deposit, gravel	36 feet.
Course of channel	East of north 10 degrees.
Class of bedrock	Slate.
Worked by tunnel or shaft	Tunnel.
Cost of tunnel per foot, including track	$33 25.
How ventilated	By shaft.
Kind of drill used	Hand drill.
Kind of powder used	Giant No. 2 and Black.

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Kind of gravel	Both free and cemented.
Method of recovering gold	By washing.
Width of channel drifts	150 feet.
Depth of gravel drifts	3 feet.
Percentage of cobbles and bowlders	50 per cent.
Number of carloads extracted per shift	3.
Number of shifts per day	1.
Number of men per shift	5.
Weight of carload of gravel	2,500 pounds.
Value of gold	$18 37 per ounce.
Quantity of water used for washing	100 inches.
Kind of timber used	Spruce, pine, and cedar.
Source of supply	Centerville.
Distance to supply	7 miles.
Cost of, as measured	4 cents per foot.
Kind of lumber	Pine and spruce.
Source of supply for lumber	John Hupp's Mill.
Distance to supply	4 miles.
Cost of lumber as measured	$20 per thousand.
Source of water supply	Small ravine and tunnel.
Length of ditch	One quarter mile.
Head of water	30 feet.
Length of water season	All year.
Number of men employed	5.
Average wages paid per month	$50 and board.
Length of channel worked	2,400 feet.

MAGALIA CONSOLIDATED.

In Magalia Mining District, two and a half miles from the town of Centerville, on Sec. 10, T. 22 N., R. 3 E., M. D. M.; the claim covers five hundred and twenty acres, and was located in 1880. The course of the channel here is northeast and southwest. Owing to the pitch of the the bedrock the old works had to be abandoned more than a year ago, and a new tunnel was started west of the old works which will intersect the channel at greater depth.

The driving of the tunnel was let by contract for $5 70 per foot, and as it is being driven through a soft sandstone, the parties are using a sand auger instead of drills, with giant powder No. 2. The tunnel is six feet four inches by five feet in the clear, and one thousand two hundred feet have been completed. The ventilation is effected by water blast under thirty-five feet of pressure; the tunnel will be driven till gravel is struck, when drifting will again be commenced.

BUTTE KING AND BUTTE QUEEN.

These two adjoining properties are under one management. They cover forty and sixty acres, respectively, and are located on Sec. 20, T. 25 N., R. 5 E., in the Golden Summit Mining District. On the Butte King, a bedrock tunnel was run three hundred feet; the tunnel was continued two hundred feet through gravel, and a shaft sunk twenty-eight feet to bedrock. Drifting was started on an incline of 40 degrees for a distance of forty feet, when the works had to be abandoned on account of the amount of water encountered. On the Butte Queen developments enough have been made to determine the channel for a length of one thousand feet; a tunnel has been driven one hundred and twenty feet, also forty feet across the channel, but without yet determining its full extent. It is an ancient river channel, lava capped, coursing north and south with a slate and gray porphyry bedrock. Steam pumps are in course of construction.

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BROWN RAVINE TUNNEL COMPANY.

This claim adjoins the preceding one and is on the same section, township, and range. The ravine it is situated at the head of, was famous in an early day for its gold production. The property comprises three claims with a combined area of one hundred and sixty acres. The former works, which consisted of a bedrock tunnel in granite one hundred and five feet long and an eight-foot shaft at the end of it through hard lava, where some gravel was found in the bottom, had to be abandoned on account of the water encountered. Another tunnel has been started lower down near the head of Brown's Ravine, which is in two hundred and sixty feet, and will have to be run in about as much farther to strike the gravel.

The work is being done by contract, at $3 50 per foot. So far it has been through hard granite; the remainder will be in quartzite, granite, and hard slate. The most of the surrounding country is lava-capped, with little or no soil, and strewn with lava bowlders. Brown's Ravine has, at its lowest time, a flow of about twenty-five miner's inches. At present it is running about one hundred inches.

SOUTH FILLBROOK.

Situated on Sec. 20, T. 25 N., R. 5 E., at an altitude of six thousand feet; in Golden Summit Mining District; covers an area of fifty acres. A bedrock tunnel is being run through granite and conglomerate rock, and has already attained a depth of one hundred and eighty feet, which it is estimated will reach the gravel deposit aimed for at a total length of three hundred feet. The course of the tunnel is east of south. The country is heavily timbered—mostly fir. Work was suspended during last winter, and not resumed till August first.

AURORA.

Situated on Sec. 13, T. 23 N., R. 3 E., M. D. M., in Magalia Mining District, three and one half miles from the town of Magalia. Has been idle for some time on account of litigation, which is, however, now in the way of settlement, when operations will be resumed. Flattering prospects have been obtained here in the past, and its near proximity to the Lucretia, or Pershbaker Mine, seems to inspire the belief that it may prove its equal.

The mine is opened by a shaft ninety feet in depth, from the bottom of which a tunnel thirteen hundred feet in length has been driven to the channel, which has an average width of twenty feet. The gravel in the channel is free; the course of the channel is northeast and southwest.

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At about one thousand feet from the southerly end of the claim considerable surface work has been done, yielding, it is stated, rich pay, some extremely rich gold quartz being found. The vein from which these specimens evidently came is in slate formation, the vein matter consisting of alternate strata of slate and quartz.

In the portion of the claim above spoken of, a tunnel has been run a distance of one hundred and fifty feet, crosscutting the country rock in an easterly direction. It was abandoned before reaching the vein.

At about one thousand feet from north end of the claim some indications of copper ore were discovered several years since; it lies immediately west of the gold-bearing quartz and is running parallel with it. At present there is no work being done.

ILLINOIS.

This claim is fifteen hundred by six hundred feet, situated six miles from San Andreas, on road from San Andreas to Copperopolis.

The nearest railroad is at Valley Springs, distant fifteen miles, it being the terminus of the San Joaquin and Sierra Nevada Railroad.

Altitude of mine at shaft by aneroid is twelve hundred feet.

The general course of vein is northwesterly and southeasterly. The outcrop is exposed for ninety feet, that is, this is the length of outcrop of the shoot on which the only work thus far has been done. A vein of stratified quartz is observed here, on the hanging wall side; this vein is four feet thick, carrying an abundance of sulphurets, also free gold. On the west or foot wall of this vein there is what is known as a bowlder ledge of varying width, which is of lower grade. The foot wall is black slate, the hanging wall classed as diorite. The dip of vein is to the east, at an angle of 55 degrees from horizontal. A shaft one hundred feet deep has been sunk at the north end of the croppings.

Besides these there are some slight outcroppings several hundred feet north of the shaft. The position and course of vein observed here seems to point to this as being on the foot wall vein of the Mother Lode. No work is now being done on the mine.

The facilities for obtaining water are very good. Water can be had to the amount of eight or ten miner's inches from a group of springs on the east face of Bear Mountain, and brought upon the ground under a pressure of two hundred feet, by using a half mile of pipe. Water may also be had from the Union Ditch (which takes its supply from the Stanislaus River), by repairing an old ditch which is a branch of the same, and can be brought upon the ground under a head of one hundred and fifty feet.

There is an abundance of wood on the claim, and it can be purchased at $2 50 to $3 per cord.

THE FELLOWCRAFT.

Located in San Andreas town site, about a quarter of a mile east from the center of the village. Course of vein or veins is northwesterly and southeasterly. Size of location, one thousand five hundred by three hundred feet.

There appears to be several almost parallel strata, some of which, it is stated, have yielded very rich rock. A tunnel was run years ago starting close to the western boundary, and near its center longitudinally,

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COLUSA COUNTY.

By W. A. Goodyear, Geologist, and Assistant in the Field.

We made Camp No. 20 at Mr. Brim's, in the western edge of the upper part of Bear Valley, nearly opposite the south end of the Bear Valley Buttes. The following morning the rest of the party traveled south, directly down Bear Valley, while I first visited the Buttes.

To the north of Bear Valley, and in the direction of the prolongation of its axis, lies Big Indian Valley, or as it is generally called, simply Indian Valley, which drains, as I am informed, into Stony Creek. The divide between the heads of Bear Valley and Indian Valley is low on either side of the Buttes, which form a ridge running northerly and parallel with the axis of the valley for several miles from a point opposite Camp No. 20, to the divide which separates this from Indian Valley. I estimated the height of this ridge about five hundred or six hundred feet above the valley on either side, and its crest is peaky and ragged.

This ridge, that is, the Bear Valley Buttes, appears to consist entirely of beds of pebbly conglomerate made up of an aggregation of small pebbles precisely similar to the patches noticed on the crests of the high metamorphic ridges to the west, and interstratified with beds of entirely unaltered sandstone from a few inches to a few feet in thickness, the whole striking north 20 degrees west magnetic, and dipping easterly about 35 degrees, the weathered faces of the beds broken squarely off along the western side forming the ragged crest of the ridge. In some of these sandstones, and in the finer gravel-rock, I found impressions of small fossil shells, of which I made a collection.

On leaving the Buttes I took a trail which leads easterly across the hills to Colusa. I traveled into these hills about a mile and climbed the crest of the highest one near at hand, which I estimated to be perhaps eight hundred feet above Bear Valley.

The whole region between here and the edge of the Sacramento Valley is made up of a succession of low parallel ridges with little valleys between them. But few points in any of the ridges east of here are higher than is the one I reached. The general course of these ridges in this vicinity is about north 20 degrees west magnetic, but towards the north they appear to curve somewhat more to the west, while to the south some of them appear to have a more northerly or even a northeasterly course. They appear to consist everywhere of entirely unaltered sandstones and pebbly conglomerates with more or less clay shales, etc. At this point the sandstones strike north 20 degrees west, and dip about 50 degrees to the east. This is probably, however, rather an exceptionally high angle of dip. But so far as can be judged from the appearances as seen from here (though the exposures around here are not very good and the rocks do not show much from a distance), the dip everywhere between here and the Sacramento Valley is probably to the eastward, and the strike nearly parallel with the axes of the ridges.

Much of the sandstone is micaceous and shaly. There is some very

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strong brine of common salt, mingled probably with minute quantities of other salts, proceeding from springs in the hills above.

Wilbur's Springs are in the hill on the north side of the spur, between these gas springs and Sulphur Creek, on the south side of the main cañon of Sulphur Creek itself, and, perhaps, two hundred feet above its bed.

The three principal springs come out from beneath the outcrop of a heavy bed of shale which has apparently been decomposed and replaced by lime, forming now, at least upon the surface, a mass of impure tufa, containing more or less shale, etc. This bed is conformable with the rocks just below it, which strike north 40 degrees to 50 degrees west, and dip at high but varying angles to the southwest.

These three chief springs are all hot, and are all of them very strong salt brines, impregnated also very strongly with sulphuretted hydrogen, and depositing sulphur rapidly on exposure to the air. The sulphur, however, does not accumulate here, as the running water and the winter rains carry it off. I had no thermometer here to measure the temperature of these springs, but the water is decidedly too hot to be borne steadily by the naked hand, and as nearly as I could estimate, I judged it to be probably in the vicinity of 150 degrees Fahrenheit. The soil within a foot or two of the running water, *i. e.*, where damp, is often covered with a slight efflorescent coating of chloride of sodium, and the edges of the little rivulets themselves are bordered with a continuous line of yellow sulphur crust. The waters also contain iron in small quantities, and the bottoms of the rivulets are black with sulphide of iron. A short distance below these hot springs is a cold spring, whose water is very similar to that of the hot ones, but cold. Immediately above the cold spring the rocks are wet with trickling water, which is very briny, but seems to contain but little sulphur. The water of the main Sulphur Creek, above where these springs come into it, is also briny, stronger, I should think, than sea water, and probably contains a variety of other salts in smaller quantity, though it does not seem to contain much sulphur. In fact, the sulphuretted hydrogen of the adjacent springs, and especially the hot ones, appears to escape quite rapidly everywhere on exposure to the air, from the water which holds it in solution.

All the water which trickles down the rocks on the south side of the cañon at various points in this vicinity is also briny.

There is said to be in the hills among the southern headwaters of Sulphur Creek, and probably within a mile southwest from Wilbur's, a spring whose water is hot enough "to cook an egg."

The water of Sulphur Creek, and generally of the springs, is decidedly soapy to the feel, and in places along its bed it makes considerable foam, which accumulates here and there in white bunches sometimes a foot or more in diameter. It furthermore deposits more or less sesquioxide of iron at considerable distances from its origin, and after it has lost most of its sulphuretted hydrogen.

Wells which have been sunk at various points along the cañon of Sulphur Creek give generally pretty good drinking water in spite of the close proximity of the briny creek.

The rocks at Wilbur's are unaltered and partially altered sandstones and shales. About one hundred and fifty yards below Wilbur's is a well in the bed of the cañon, about ten feet deep, which used to be called the "white sulphur water." It is situated perhaps ten or twelve feet from

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road. I found, moreover, both sulphuretted hydrogen and common salt in the water of the gulch at points considerably higher up than these.

From the mouth of Larry's Cañon to that of Sulphur Creek, the rocks, which are all unaltered along Bear Creek, continue to have the same general strike, a little west of north, and the same high dip to the east; but along the cañon of Sulphur Creek from near its mouth to Clark's Spring the rocks are generally metamorphosed, and much of the stratification is obliterated.

Clark's Spring is in the first little gulch east of his house and south of Sulphur Creek. It is a warm spring. I should think it might be 110 degrees Fahrenheit, and contains sulphuretted hydrogen, iron, chloride of sodium, and some other salts which give it a slight bitterish taste. No rock is exposed at this point. Within fifty feet or less of this sulphur spring there is a spring of good, cold water, used for drinking and culinary purposes.

The Colusa Sulphur Banks are in a belt of decomposed serpentinoid and clay rocks, running obliquely up the hills on the left bank of Sulphur Creek, about a quarter of a mile west of Simmons' Springs.

Several large excavations or open cuts have been made here in the mountain side, separated by intervals of a few hundred feet. These cuts are very irregular in shape, and the largest one is probably not less than seventy-five feet in depth. The sulphur appears to be distributed to a greater or less extent throughout nearly the whole mass of the soft and decomposed material so far as the cuts extend. But the quantity of ore in which the sulphur is sufficiently concentrated to admit of profitable extraction, appears to have formed comparatively but a small proportion of the whole mass excavated, and, indeed, although there is certainly some ore here which is rich in sulphur, yet the question whether there is enough of it to be capable of profitable extraction is one which does not appear to have been satisfactorily settled.

At the works which were erected in the cañon, they had six D-shaped retorts of thick cast-iron, each about four feet wide, six or seven feet long, and one foot high inside.

The flame from beneath played around the sides and over the tops, as well as under the bottoms of these retorts, and thence into the flues over the tops leading into the chimneys at the back ends.

Alongside of the chimney for each retort was a condenser, a vertical cylinder of rolled iron three or four feet in diameter and six or eight feet high, from the bottom of which the liquid sulphur was drawn. Surmounting each of these iron condensers was a short brick chimney, covered at the top by a plate of boiler-iron, held down only by its own weight. From an opening in the side of each of these little chimneys, just beneath the top plate, board flues converged to a single large brick condensing chamber, where some more sulphur was saved.

The total quantity of sulphur extracted from here is said to have been considerable, and it is stated that there was not sufficient mercury in the ore to give any serious trouble; yet the experiment appears to have been from some cause a financial failure, and the works are now standing idle. But whether the cause of this lies really in any scarcity of ore which might be profitable if skillfully and economically worked, or whether it lies rather in past mismanagement of the works, which it has been alleged were conducted with ignorance, extravagance, and recklessness combined, I could not with certainty learn.

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and some twenty feet apart. The locality is about one half a mile below the mouth of Sulphur Creek, in the hills on the right bank of Bear Creek, and he estimated about one thousand feet above its bed. The strata here strike northwesterly and stand nearly vertical.

Mr. Craven, on a trip to a point of observation among the hills some three miles southeasterly from Clark's Springs, found the country chiefly metamorphic until within about three quarters of a mile of his point of observation, around which all was unaltered sandstones and shales, striking a little west of north and dipping about 40 degrees southwesterly. Nothing which looked volcanic was seen in this region north of Cache Creek. I was informed by Richard Abbott, owner of Abbott's Quicksilver Mine, that the outcrop of a fossiliferous bed may be seen on the highest point of the hill on the right bank of Sulphur Creek, nearly opposite the sulphur banks. Close by a creek, in a spur of these same hills, there is considerable cavernous rock containing much lime, and some rather handsome specimens of stalactitic lime incrustations have been found here.

There are portions of some of the fossiliferous beds in this region which consist chiefly of shells and their fragments, and some of the rock contains so little other earthy matter that it is said to make good lime on burning.

Relative to the locality of gold and cinnabar in the bed of the gulch of Sulphur Creek between Clark's and Simmons', Dr. Hughes, of Lower Lake, who was interested in the matter at the time, tells me that some of the same kind of specimens were found in the Manzanita Tunnel, and also that the washing of the material from the bed of the creek just below the tunnel, paid for awhile something more than $3 per day per man in gold alone, and that the value of the cinnabar obtained at the same time nearly equalled that of the gold.

The present road from Lower Lake to Knoxville lies to the south of the old road.

Along this road I saw nothing but unaltered sandstone until about four miles from Lower Lake. For a mile or two of this distance there runs along close by the roadside a ridge of heavy bedded sandstones, whose direction of stratification is somewhat uncertain, but which seemed to strike about north 60 degrees west magnetic, and dip some 50 to 60 degrees southwest.

At a point about three and one half miles from Lower Lake the road crosses the crest of a rather low divide between the waters of Clear Lake and the head of Soda Creek, which runs southeasterly to Puta Creek.

About a mile beyond the crest of this divide is Dr. Baker's place, on Soda Creek, near which there has been some mining done for quicksilver.

Here I stopped and visited several points of interest with the doctor. At one point on the right bank of Soda Creek, where the road descends a pretty steep grade to the creek, a tunnel has been driven in some distance directly in the road in search of quicksilver, but nothing of any account was found here.

Traveling a short distance up a cañon to the north from here we found a "soda spring," containing free carbonic acid, lime, and iron, and just above it in the cañon another prospecting tunnel where, also, nothing of value was found. A little farther down the cañon, and on the sidehill northeast of its bed, is another spring which is warm, running perhaps 75 to 80 degrees Fahrenheit, and discharges very little

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rock noticed between Little Indian and Bear Valleys, containing foliated (pyroxenic) crystals. From here on I saw nothing but metamorphic rocks until dark, and reached in the evening Camp No. 23 at Knoxville.

The condition of the quicksilver mines of the region about Knoxville in 1870 has been very fully described in the "Geology of California, Volume II—The Coast Ranges, Appendix," published by Prof. J. D. Whitney at Cambridge, Mass., in 1882, and an extensive monogram upon the quicksilver mines of California has recently been published by Mr. Geo. F. Becker, of the United States Geological Survey. They will not therefore be described here.

For the sake of what follows, however, it may be stated that the Manhattan Mine is at Johnstown, about two miles northwest of Knoxville; the Reddington Mine is at Knoxville; the Andalusia Mine is about four miles somewhat west of north from Knoxville, and the Reed Mine is about three fourths of a mile southeast of the Andalusia; the last two being in the cañon of a little branch of Davis Creek, which runs to Cache Creek, while Knoxville is at the head of Eticuera Creek, which runs to Puta Creek.

In the bed of the cañon near the boarding house, and about opposite the Andalusia claim, there is an outcrop of unaltered sandstones and shales, some of which are fossiliferous. These rocks strike northwesterly and dip northeasterly at high angles. A little lower down the creek they stand vertical. The bed of the cañon is also strewn with bowlders of pebbly conglomerate, and there are said to be considerable quantities of this material in the mountains just west of here, some of it in beds upturned at considerable angles.

A strip of carbonaceous shale some three or four inches in thickness was observed in the bed of the creek a little above the experimental reduction works at the Reed Mine. In a few places in this vicinity the unaltered shales are said to have a westerly dip, but I saw no such case, and the general rule is easterly.

The crest, and probably the chief mass of the ridge next east of this cañon, is metamorphic. The much higher ridge next northeast of this one, which continues on southeast between Knoxville and the great unaltered cretaceous crest beyond it, is probably also metamorphic. It is possible, indeed, that there may be some volcanic matter somewhere along this ridge, and one or two points along its crest had rather a suspicious look in this respect. But I saw nothing which I could recognize from a distance as volcanic anywhere to the east of the road which I followed from Knoxville to the Reed and Andalusia Mines.

At Knoxville, a little below the Post Office, there are also some unaltered shales and strips of altered and unaltered rock, which appear, to some extent, to alternate and bifurcate into each other with much irregularity.

I should have mentioned that all along the road, between the Manhattan Mine and Knoxville, there are numerous spots where springs have deposited masses of calcareous tufa, and the bed of the gulch is frequently cemented into a conglomerate. The difference of level between the Manhattan Mine and Knoxville appears to be about seven hundred and fifty feet.

The following information is extracted from a letter received from Mr. J. P. Rathbun, dated Williams, Colusa County, September 1, 1890:

"As to petroleum discovered by my brother and myself, our first dis-

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coveries were on the S. ½ of the S. ½ of Sec. 35, T. 14 N., R. 5 W., and on the N. ½ of Sec. 2, T. 13 N., R. 5 W., M. D. M. They lie in a steep ravine alongside of a running brook.

"The petroleum oozes out of rock over a space ninety to one hundred feet long and six feet wide. The greater portion is carried off by the water of the stream. But there are pot-holes in the rock from which it oozes, above the water, out of which one may gather several gallons. It comes to the surface through a serpentine formation; but black shale crops out a few feet below. We have also found it on similar lands in six or seven other places where it runs out possibly a bucketful every twenty-four hours. Some of the places it runs out of are a rusty sandstone, and some of them are in a little valley all surrounded by high mountains. The locations were found on the twelfth of August.

"This oil field seems quite extensive, as we have found it for twelve miles square or more, and from what I know of the country, I think it is much more. It lies between Cache Creek and Bear Creek, and is within a few miles of the survey line for the proposed railroad to run from Capay to Lower Lake. A good road reaches it. We are now running a small cut into one of the springs, and find the ground full of oil thirty feet away.

"On Peter Peterson's place, three and one half miles north of Sites, in Antelope Valley, near the Colusa and Lake Railroad, and twelve miles from Maxwell on the California and Oregon Railroad, in this county, are a number of salt springs running out into a lake of twenty-five acres, which I have drained. I have been experimenting this season, and find that it is only a question of vats to evaporate the water by solar heat. It is possible to make several hundred tons of salt each year, as I expect to do in the coming year."

Mr. Rathbun has furnished the Mining Bureau with an average sample of the salt manufactured by him. An analysis of it shows $96\frac{84}{100}$ per cent of sodium chloride.

A partial analysis of water from one of the salt springs gave three thousand one hundred and fifty-nine grains of solid matter to the gallon, of which nearly one half was sodium chloride—the remainder of the residue being composed chiefly of calcium chloride. The interesting feature, however, is the fact that the water contains over two grains of iodine to the gallon.

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CONTRA COSTA COUNTY.

By W. A. Goodyear, Geologist and Assistant in the Field.

At the old Mount Diablo mines at Somersville, on the first of May, 1890, a small amount of coal was being extracted from the old Eureka Company's ground; but none of the other mines at Somersville were producing any coal. The Pittsburg Company, however, after having failed in an attempt to pump out, clean, and retimber the old Independent shaft, were then employed in sinking a new shaft at a point about one hundred feet north of their old hoisting works, at the mouth of the slope. This shaft had then reached a depth of two hundred and thirty feet. It is in two compartments, timbered with eight by eight-inch timber, each compartment measuring seven feet eight inches by four feet eight inches inside the timbers.

The Stewart Mine, also, was idle at this time, while the old Empire Mine, after going down one thousand two hundred feet on the dip of the bed and producing a very large quantity of coal, has long since been abandoned.

A short distance to the west of the old Empire Mine, however, a new slope has been sunk, which is called the West Hartley, and through this slope they are now working on both the Clark and Little veins. The slope is said to be four hundred and fifty feet deep, and the coal at the bottom three feet thick.

It is probable that the Stewart Mine will be again opened, and continue to produce a large quantity of coal for a considerable length of time to come.

Some four or five miles southerly from Martinez a locality was visited on the property of the Smith Brothers, where some prospecting has been done for coal, and a tunnel has been driven some twenty-five or thirty feet into the hill. But the rocks are highly metamorphic, and no indications exist to justify any hopes of finding coal here. Some very strong mineral waters, however, were found, which vary considerably in character. Some of the water is supersaturated as it issues from the rocks with sulphuretted hydrogen gas, which escapes from it in bubbles; while some of it is a very strong solution of various alkaline salts, among which the sulphates seem to predominate. Some three quarters of a mile northwesterly from here, in the bottom of a very steep cañon, there is a beautiful, strong, and copious sulphur spring, whose water seems to contain but little else than sulphuretted hydrogen. All these waters are cold.

The locality of basalt rock on the lands of Matthewson & Blackmar, about three and one half miles from Concord, which is referred to on page 162 of the Eighth Annual Report, was again visited. It appears to be a completely isolated outburst, roughly oblong in form, and with its longer axis lying in a direction of north 45 degrees to 50 degrees west magnetic. Its extreme length is little, if any, more than a mile, while its greatest visible width may, perhaps, be a little over a quarter of a mile. Its occurrence here is especially noteworthy as being the only instance where volcanic rocks, or indeed eruptive rocks of any kind, are yet known to exist in places anywhere in Contra Costa County, while none whatever are known in Alameda County.

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there are one hundred and ninety-two thousand acres of redwood still standing in the county.

The following table shows the exports for the year 1889:

Hobbs, Wall & Co., feet of lumber	6,740,284
Crescent City M. & T. Co., feet of lumber	4,899,990
Beitsch Brothers, shakes	1,288,000
Sundry shakes	84,000

CHROME IRON.

Extensive deposits of chrome iron can be found in Secs. 5 and 6, T. 16 N., R. 1 E.; also, in Secs. 33, 34, and 35, T. 18 N., R. 2 E. These properties are all patented, and belong to the Tyson Mining Company, of Baltimore City, Maryland. All the products of the various mines are shipped to that city for treatment. Other deposits have been found in the county, but are too far from transportation to be utilized at present. Very extensive deposits can be found in the Rattlesnake Mountain, twenty miles east of Crescent City. The deposits there are from ten to fifteen feet in width. They are owned by D. P. Gordan and others.

BUILDING STONE.

Located in Sec. 22, T. 16 N., R. 1 E., H. M., one and one half miles northeast from Crescent City, is a large deposit of superior sandstone suitable for building purposes; it has been worked to a limited extent, furnishing stone for local use. No work is being done at present on the property.

COPPER ORE.

Copper ore has been found in various places in this county, and of high grade, and would probably pay if proper reduction works were erected on the properties. In 1862 and 1863, there was quite an excitement in copper mining here, and considerable money was expended. The ore was shipped to Swansea, Wales, but the expense of mining, hauling, and freights, with working charges, was too great, so work was suspended and has never been resumed. The Alta and the Union are the principal properties, and most of the work and money expended was on these properties.

Some prospecting work was done on the Condon Mine, which is located in the Big Flat District; a tunnel was run on the vein one hundred feet, giving a vertical depth of say seventy-five feet. The vein has a north and south course, and dips from 30 to 45 degrees to the east. The vein will average about six feet in width; it is located about thirty miles east from Crescent City. The ore is rich in copper on the surface, but as depth is attained it contains more iron than copper. In the Rockland District, about thirty miles east from Crescent City, large deposits of red oxide of copper were found. It averaged from 60 to 70 per cent on the surface. The vein, four feet wide on top, at a depth of fifty feet pinched out.

CRESCENT MINE.

This mine is located in Bald Hills District, about twelve miles northeast from Crescent City. About $10,000 have been expended in endeavoring to put this property on a paying basis, so far without success.

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THE MOTHER LODE—ITS VALUE AS A FIELD FOR MINING OPERATIONS.

What is known as the Mother Lode of California manifests its presence in this county in a very marked manner. As the geology, lithology, and other physical features of this lode have been described elsewhere in this volume, it remains for us here to merely consider its commercial value as a field for mining.

Entering this country on the south, this great ore channel passes clear across it, a distance, measured in a straight line, of about twenty miles.

Local departures excepted, it holds here a course nearly north 30 degrees west, cutting the general stratification of the country at a more acute angle than this. After entering the county and proceeding a few miles north, it makes a rather violent deflection to the east, carrying it into the neighborhood of Placerville. A little farther on it comes back to its normal course, which it holds till it reaches the Middle Fork of the American River, the northern boundary of the county. This Mother Lode carries with it in El Dorado County two porphyritic belts, one on each side, and both of which are mineralized to an extent that renders them here more important as the sites of large prospective mining operations than the dominating lode itself. Some geologists, in fact, hold the opinion that none of the large mines thus far found in this county are situated on the Mother Lode proper. These porphyry belts, which are separated from the central core by talcose slate, serpentine, or diorite, each occurring in different places, vary from one hundred and fifty to three hundred feet in width, their average being about two hundred feet, or a little less. Their contents consist of porphyry, quartz, talc, spar, and various other mineral substances, all more or less auriferous.

While very rich in spots the gold as a rule is so diffused through this mass that the ore to be crushed cannot well be assorted. Where the crushing plant in use is of limited capacity this, of course, has to be practiced, as is being done at the old Shaw Mine, now owned and operated by the Indian Creek Land and Mining Company. At the Dalmatia Mine, farther north, where the crushing plant is of greater capacity, every pound of this material is extracted and milled, no effort at assorting being here made. Nearly the whole of this stuff is so soft that it can be pulverized in the Huntington mill. A beginning having been made, and thus far with encouraging results, it will not be long until others and perhaps many large mining operations will be inaugurated along these broad porphyritic ore channels, the entire contents of which will be dealt with after the manner now practiced at the Dalmatia Mine.

There are located along this section of the Mother Lode, its porphyritic appendages included, nearly a hundred mining claims, on all of which more or less exploratory work has been done, many of these claims having been equipped with costly plant and developed into largely productive mines. Concerning such of these properties as are not now being worked, no mention need here be made, nor will it at this time be practicable to give a detailed description of the others, their number being so great. But for this there exists no urgent necessity, as the most of these have been described in preceding volumes of this series.

Starting in on the south and journeying along the central fissure and its companion ore channels, we pass five or six mines on which nothing is being done. These are not dead properties, but, for one reason or

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average of $13 per ton, exclusive of sulphurets. Encouraged by the results obtained, the company contemplate various improvements on their property.

The present ten-stamp mill will be enlarged as soon as developments in the mine will enable the ore to be dropped instead of being raised; also, additional concentrators are to be added, and, as far as practicable, the entire machinery run by water. In July, the company's mill was run for eighteen days on $8 and $9 ore; in August, a sixteen days' run was made on $13 ore; September's run for the same number of days showed a steady improvement in the quality of the ore. The concentrates, amounting to about two tons per month, of an average value of $100 per ton, are shipped partly to the Sutter Creek Chlorination Works, and partly to the Selby Smelting Works, near San Francisco.

North of this property, situated on the Mother Lode or its adjuncts, are the followiing claims:

THE EQUATOR, SUPERIOR, MILLER, GRIFFITH, MANZANITA, ORIFLAMME, AND MATHINAS CREEK.

On all of these more or less work has been done during the past year; not on all of them, however, has the work been continuous.

The Mathinas Creek Mine has been opened by two tunnels, one hundred feet and three hundred feet long, respectively, exposing a vein of fair grade ore, containing 3 per cent of sulphurets. A Huntington mill belongs to the plant, but is not running at present. An early resumption of the work is talked of here.

On the Equator Claim a tunnel now in one thousand three hundred feet has crosscut three distinct gold-bearing veins at a depth of five hundred feet. They average from ten to thirty feet in thickness, and yield, by mill process, from $8 to $12 per ton. Each of these veins has been drifted on for a distance of one hundred feet. The large amount of water coming in at the face of the main tunnel, which is being pushed ahead, would seem to indicate proximity to another large vein. There is a good opportunity here to develop a low grade mine of considerable extent; enough ore is exposed at present to keep a small mill running over a year.

Two tunnels have been driven in the Superior Mine, the upper one two hundred and fifty feet, and the lower seven hundred and fifty feet in length, the latter attaining a vertical depth of one hundred and sixty feet. The pay shoot, intersected in this tunnel at a point two hundred feet from its mouth, varies in thickness from two to ten feet, and yields, in the ten-stamp mill of the company, an average of $15 per ton, in gold. During the past year the mill has been changed from a steam to a water mill. Five thousand four hundred feet of eleven-inch pipe were required to bring the water on the ground.

The exploratory work on the Miller Mine, which is doing very little at present, consists of two shafts, each thirty-five feet deep, and a connecting tunnel one hundred and twenty-five feet in length. A body of good ore about three feet in thickness has been exposed.

On the Griffith Mine, opened by a shaft one hundred and fifty feet deep, a five-stamp mill run by water has been put up, but it has not been running nor has any work been done on the mine of late.

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Owing to the width of the deposit, and the fact that the entire mass is being taken out and milled, no greater depth than twenty feet will be required for a long time, with the present crushing capacity. The mill is run by a Pelton wheel, working under a pressure of one hundred and seventy feet.

Half a mile north of here we find

THE DALMATIA MINE AND MILL,

Occupying, like the Big Sandy, a place on the east porphyry belt. This has the distinction of being the first mining enterprise in California to make use of electric power for the purpose of propelling mining machinery.

The Dalmatia Mining Company (limited) is an English corporation. Their property is situated in the Kelsey Mining District, seven miles north-northwest of Placerville, on what is known as the Georgetown Divide.

The lateral belt in which this company is working has a width here of one hundred and fifty feet, and is made up chiefly of porphyry and quartz, much decomposed, intermixed with spar and a small percentage of oxide of iron, etc. The whole mass is so loose that it can be broken down almost entirely with the pick, only small bunches of quartz requiring an occasional shot.

In the first instance the mine was equipped with a steam hoist and a ten-stamp mill, run by steam, but as the assorted ore only averaged $3 per ton, not enough to cover expenses, the Superintendent, to reduce expenses, concluded to introduce the electric motor in place of steam, and to open the mine by a tunnel, in the hope that with a cheaper propulsive power the ore could be extracted and worked with profit. The Rock Creek ditch, carrying four hundred inches of water, was bought. This creek takes its water from the South Fork of American River and delivers it nearly two miles further south, and one thousand three hundred feet below the mines. At the same time the right for a reserve force of water directly out of the South Fork of American River was bought, this latter amount having to be returned into the river. The water from the Rock Creek ditch is delivered on a seven-foot Pelton wheel under a pressure of one hundred and twelve and one half feet. With this wheel an electric generator of one hundred and twenty-six horse-power has been connected. From this generator two wires extend to the motor located in the mill, which is situated on the ridge one thousand three hundred feet above and nearly one mile distant in an air line. From a pulley on the motor a belt transmits the power direct to the main shaft, which controls all the machinery in the mill, consisting of a Dodge rockbreaker, a set of Challenge ore feeders, three Huntington mills, and ten stamps. Beyond this, water brought in through a small ditch from another source, and delivered on a Pelton wheel, generates electricity for the electric plant with which the mill is lighted.

A tunnel one thousand two hundred feet long was run from a point a little above and a few yards distant from the mill, to the east into the center of the ore belt, its inner extremity connecting with the bottom of the shaft put down from the surface to a vertical depth of seventy-five feet. From the bottom of this shaft a tramway has been laid through the tunnel and down to the mill. The ore is broken from the sides of a large excavation, cone-shaped, and dropped through the shaft into the

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THE BONA FORSA MINE.

This claim, which lies northwest of Placerville, comprises one hundred and sixty acres held under United States patent. It contains two veins or ore channels, the one thirty feet wide, coursing north and south, and the other eight feet wide, crossing the former at an acute angle. In an early day the surface was worked as placer, having been extremely rich in gold. Two vertical shafts have been put down on these ledges, one to a depth of sixty-five feet and the other of fifty feet, considerable crosscutting having been done at the bottom of these shafts. The ore here below, to a depth of thirty feet, consists almost wholly of sulphurets, rendering its reduction by ordinary mill process impracticable, on which account the company have been obliged to shut down their mill. These sulphurets are, however, exceedingly rich in gold, and would pay well if treated by some suitable process. The company have an ore crusher of the National roller type, which was put up a little over a year ago. Their machinery is run by water obtained from the El Dorado Water Company, for which they pay $5 per day.

QUARTZ MINING IN OTHER PARTS OF EL DORADO.

The Gentle Annie Mine is an old location, having had a mill on it twenty-five years ago, all of which had been removed and the mine abandoned. Lately it has been resuscitated. There are a series of four veins on this claim, varying in thickness; they are respectively two feet, ten feet, eighteen feet, and twelve feet wide. A tunnel has been driven across all four for a distance of three hundred and fifty feet. At a depth of one hundred feet from the surface, the first vein was cut by the tunnel. A new tunnel has been started at the north end of the mine. It is connected by a tramway with the ten-stamp mill, the ore in which yields $4 per ton in free gold; carrying also 5 per cent of sulphurets, worth from $50 to $80 per ton.

The Berryman and Coleman Mines are being opened by a tunnel. As soon as this penetrates to the vein it will receive the necessary plant and be actively operated.

The Codlin Bros. put up in April at Steeley Fork on their mine a five-stamp mill, which has since been running successfully.

A tunnel was commenced early in the year on the ledge outcropping along the east side of Dark Cañon at the Bright Hope Mine. Work on this tunnel, which for a number of years has been in progress on the ground of the Frue Consolidated Company's Mine, has been continuous. A body of good ore has been lately developed here. The tunnel run in the ledge has been in low grade ore most of the way; bunches of the same kind of ore having been found also in the croppings. The company's mill, which has been running part of the time, is shortly to be replaced by a larger one.

About Grizzly Flat, an important quartz mining center, there has been considerable stagnation in mining operations during the past year, none of the companies in that vicinity having kept their mills running steadily; some even have not been running at all. What makes this condition more noticeable is the fact that many of the mines there have been thoroughly exploited and equipped with plant, and could no doubt be made to yield large quantities of good and even high grade ores. Towards the end of the year the mining industry commenced to revive suffi-

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near the surface. These deposits occur in greatest abundance near Greenwood, Georgetown, Spanish Dry Diggings, and Georgia Slide, where a good deal of this sort of work is still in progress.

The plan of washing the material broken out of these narrow gold-bearing veins by the hydraulic process had to be abandoned, as most of the gold was carried off in the tailings. Latterly the small quantities of this material taken out is crushed with stamps, being treated in the same way as the cemented gravel from the drift mines.

DRIFT MINING.

The plan of extracting the auriferous gravel from the ancient rivers and other deep-lying channels, by means of drifting, has been and still is an important branch of gold mining in El Dorado, the business being actively pursued at the present time in many parts of the county.

The most extensive and well stocked of these drift channels, so far as known, commences at Placerville and extends thence east for an indefinite distance, the drift deposits near the town having been pretty well worked out. The site of present operations in this line of mines lies several miles farther east, in the neighborhood of Smith's Flat, Cedar Ravine, and Chili Ravine.

NEAR SMITH'S FLAT.

The Rogers Mine, which, together with the Linden and the Chili Ravine Mines, were fully described in the report of 1888, has been run continuously throughout the year, and with the usual good results, some very rich gravel having in the meantime been discovered in this ground. This discovery has induced the owner to purchase the next claim on the east, which is supposed to cover a considerable section of the old river bed channel extending in that direction.

On the Linden Claim, in the same neighborhood, work has also been kept up without intermission, important finds having been made in this claim during the past few months, causing an increase in the working force and in the output of bullion.

During the spring work was begun on the Toll House Claim, located on the same channel with the Rogers property. This is an old claim, having been partially prospected by means of two shafts sunk to a considerable depth many years ago. These shafts have been repaired, and are now being sunk deeper, others also having been started for the purpose of determining the depth at which the pay gravel lies; which done, a tunnel will be run at the proper level to bottom it, the intention being that this tunnel shall be low enough to drain every part of the channel. The work is being pushed with energy, it being the intention of the company to have their ten-stamp mill set up, and all other needed buildings erected, before the winter rains set in.

Borings have been prosecuted at several points along the Blair Claim, located on this channel, to determine the lowest point along it, with a view to running a bedrock tunnel for draining and working purposes. These borings, some of which have reached a depth of one hundred feet or more, show the channel at that point to be between three and four hundred feet wide. Should the experiment here being made tend to show that these deep-lying channels can be effectually prospected by this

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the river, and work such undisturbed ground as will pay small wages, but beyond that there is no gold mining being carried on at that noted locality.

MINES ON THE WEST PORPHYRY BELT.

The porphyry belt, running with and lying to the west of the Mother Lode, makes at some points along it a wide departure from the latter, the space between them, as at the Shaw Mine and elsewhere, being several miles in width.

The belt itself has also a variable width, it being in some places as much as two hundred feet across, while in others it is not more than twenty or thirty feet.

The Shaw Mine, an early location, now the property of the Indian Creek Land and Mining Company, a California incorporation, comprises two thousand one hundred and fifty linear feet by six hundred feet on this porphyritic belt, or as it may be more properly termed, "ore-bearing channel." Besides this mineral location, the company owns an eighty-acre tract of land lying adjacent. This property, which is situated in the Mud Springs Mining District, lies one and one half miles northerly from El Dorado Station, on the Sacramento and Placerville Railroad, with which it is connected by a first class and nearly level wagon road. It is distant eight miles south from Coloma, the spot where gold was first discovered in California.

Within the limits of the location which constitutes the above mine, we find developed some of the most notable characteristics of this west-lying porphyry belt. The vein matter here, fully a hundred feet wide between the walls, consists of quartz much shattered and decomposed, spar, porphyry, talc, etc. The walls are slate, and incline to the east at an angle of about 5 degrees from the perpendicular, the strike of the ore channel being north 15 degrees west.

This section of the channel was, in early days, the site of extensive and profitable placer operations, a broad strip along the east contact with the slate having been worked for rich pockets to an average depth of thirty feet. An enormous amount of gold was drifted out here, much of it consisting of nuggets and small bunches of quartz, the latter so rich that they were pounded up in hand mortars. Numerous broad, open trenches have been cut, and as many as twenty shafts, ranging from twenty to sixty feet in depth, have been sunk adjacent to the east wall. Along and adjacent to the west contact, a number of similar excavations, and for the same purpose, have been made. Much of the surface along Coyote Ravine, which, heading near the middle of the channel, runs west, has been sluiced off, a rich gathering of gold dust having been made there also.

Aside from these early irregular workings, this ground has lately been exploited with system and care, a shaft having been put down next the east wall to a depth of one hundred and fifty feet, and drifts extended from it five hundred feet north and south. A double compartment shaft has also been commenced next the west wall, and has now reached a depth of seventy-five feet. Besides these shafts two tunnels have been driven, the one on the east wall being two hundred and fifty feet long, and the other on the west wall three hundred feet long. Over the east shaft convenient hoisting works have been erected.

As regards ore extraction and reduction, the work being done here

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which is utilized for irrigation. At the present writing, there are in the neighborhood of nine hundred miles of ditch in operation, sufficient for the watering of thousands of acres of land.

The principal towns of the county are Fresno City, Madera, Sanger, Selma, Fowler, and Huron.

METALS AND MINERALS.

The metals and minerals of Fresno County are indeed varied; and I am inclined to the belief that as the county becomes more thickly populated, more attention will be drawn to its vast resources in this direction. There are gold, silver, copper and bismuth, iron and antimony, bituminous coal and lignite in the county, the two last mentioned minerals being now extensively worked. Large ledges of magnesite are also found. Chromite and limestone appear in many places in the county; and freestone, suitable for building purposes, also extensively exists. A large acreage of ground has been recently located for oil.

MAGNESITE.

In Sec. 5, T. 13 S., R. 24 E., there is a large vein or deposit of magnesite (carbonate of magnesia), massive and of a white color. It crops to the surface, and has an average width of about ten feet, and can be seen extending for several hundred feet in length on its course north 10 degrees east. It is incased in a hornblendic shale on the eastern side, and by a micaceous shale on the west.

LIMESTONE.

Limestone is found in large quantities in T. 12 S., R. 26 E.; in T. 12 S., R. 27 E.; and in T. 12 S., R. 29 E. It extends for several miles in length, with an average width of one and one half miles, running north and south. The lime in this section is of a good quality, and considerable of it has been manufactured; but nothing is being done with it at present, owing to its distance from market and the greatness of competition. On the western side of the valley lime is also found, principally in Sec. 24, T. 21 S., R. 14 E., where a vein is located belonging to J. E. Eastwood. It is on a line of about six hundred feet south of the track of the Huron and Alcalde Branch Railroad, and is one half mile east of Alcalde Station. The vein has an average width of twelve feet. The hills through which it courses are the foothills of the Coast Range, and at this point rise abruptly from the valley—Coalinga Valley—or rather from Waltham Creek Cañon, on which the kiln is situated, and through which the railroad runs. The cañon is several hundred feet in width, and the hills rise abruptly on either side of its almost level bed. The hills have become denuded in places, and their stratification is exposed, showing the sandstones and argillaceous shales lying at an angle of about 26 degrees, bearing northwest. The vein is undoubtedly an infiltration, and stands almost perpendicular, cutting through the formation as far as the location of forty acres extends. The limestone has a slight brownish hue when exposed to the air, due to a small amount of bituminous matter contained in it, which exudes on exposure. The strata of sandstone are, in many places, interstratified with thin

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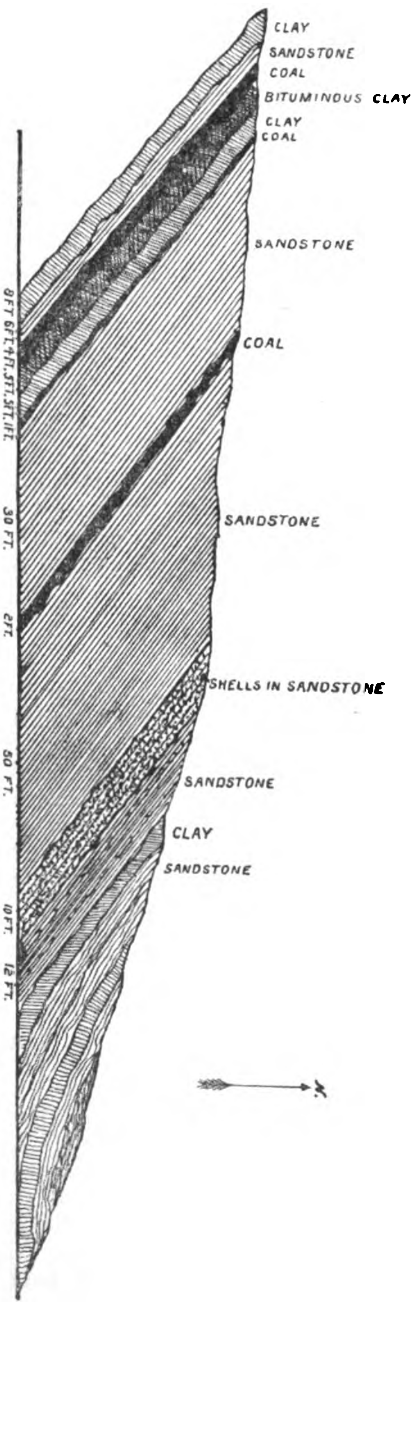
layers of gypsum, and on the northern side of the cañon veinules of gypsum exist in it several inches thick, intermixed with a brown or red oxide of iron.



FORMATION IN CROSS CUT SAN JOAQUIN VALLEY COAL MINE

BITUMINOUS COAL AND LIGNITE.

Four miles northwest of the town of Coalinga, in Sec. 27, T. 20 S., R. 14 E., is located the mine of the San Joaquin Valley Coal Company. The mine is opened by a series of tunnels. The tunnel through which work is now being prosecuted is one thousand and fifty feet in length, and is a cross-cut until the main vein is reached. In it the formation is regular in its strata of sandstones, clays, and clay shales, and cannot be better described by me than by the accompanying sketch.

Several small veins are encountered before the main vein is reached, they all being parallel with it. The main vein courses north 20 degrees west, and pitches east at an angle of 30 degrees, and has an average width of four feet. The stratum immediately on the hanging wall of the main coal vein is a compact clay, colored almost black with bituminous matter, and only lacks the luster which distinguishes it from the vein itself. This matter has an almost uniform thickness of five feet. On the foot wall is a soft sandstone six feet thick, stratified in itself with thin strata of carbonaceous matter. The tunnel is timbered in its entire length with round pine timber, costing 6 cents per foot. Fifteen miners are employed in the mine, at an average pay of $2 per day and board; and there are five outside men at $30 per month and board. The daily output from the mine averages fifteen tons, and is carried to Coalinga, a station on the Huron Branch Railroad, by a branch road built and run by the company, three and nine tenths miles long, at a cost of 50 cents per ton.

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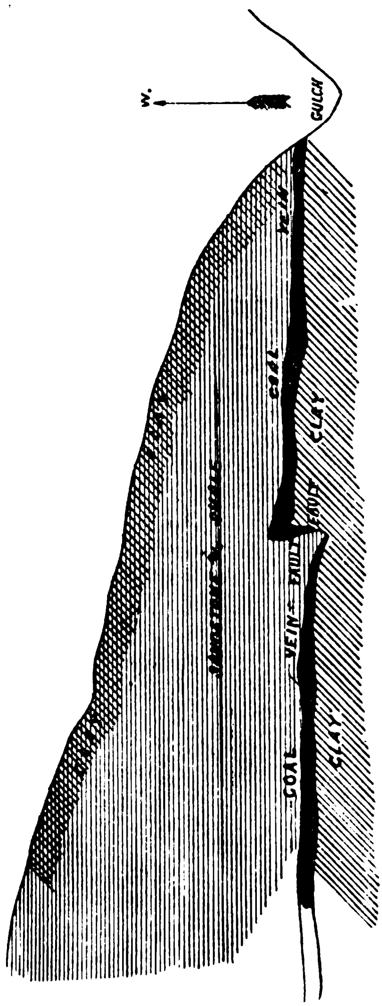
About one mile to the east in Section 26, at an altitude of one thousand feet, is the mine of the California Coal Mining Company, four miles from Coalinga by wagon road. The vein here courses north 15 degrees west, and dips to the east 35 degrees. It averages two feet in width. The hanging wall is sandstone of an arenaceous character, and the foot wall is clay. The mine has been opened by a tunnel five hundred and twenty-five feet in length, running entirely on the vein, giving a vertical depth from the surface at its face of two hundred and thirty feet. The tunnel cost $1 75 per foot to run, and is not timbered. Its dimensions are six feet in height by five feet on the bottom. The vein through the entire tunnel carries a uniform thickness, with the exception of one point one hundred and fifteen feet from the mouth, where a faulting occurs, as shown in the accompanying sketch.



The greatest length of ground worked at the time of my visit was sixty feet in length by twelve feet in height. At a distance of four hundred and ten feet from the mouth of the tunnel, an air shaft one hundred and twenty feet deep has been made, which gives a perfect circulation of air through the mine. The output of coal is as yet quite small, averaging about six tons per day. It is hauled to Coalinga by wagon, at an expense of $1 per ton.

Coal in large quantities is said to exist in Secs. 15 and 16, T. 17 S., R. 13 E., and also at various points in T. 21 S., R. 13 E.

FREESTONE.

About two miles west of the town of Alcalde, the terminus of the Huron Branch Railroad, the county road runs through a ledge of dark, slate-colored freestone. The ledge courses north 40 degrees west, and dips to the east at an angle of 45 degrees. It is of variable thickness, in places reaching sixty feet. No quarrying or work of any kind has been done. Large pieces, weighing from five hundred pounds to several tons, have fallen from the ledge to the road, and none of the pieces show signs of injurious weathering.

In Sec. 26, T. 21 S., R. 13 E., there is a ledge of freestone of good quality.

Continuing up Waltham Creek to the Fresno Hot Springs, the country shows great disturbances in many places. Deep cañons are cut by the

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THE FRESNO HOT SPRINGS.

These springs are at an elevation of three hundred feet above the level of Hot Springs Creek, and the surface of the hill is capped with conglomerate. There are several springs, varying in temperature from 80 degrees Fahrenheit, to 105 degrees. Much stress is given to the curative properties of these waters as a tonic. The principal spring is of the latter temperature. A qualitative analysis of it shows sulphuretted hydrogen gas, sulphates of lime and magnesia, chloride of sodium, traces of silica, alumina, and iron.

GRANITE FOR BUILDING PURPOSES.

Granite for building purposes is extensively quarried at and around the town of Raymond, in T. 8 S., R. 19 E. There are several quarries in operation, the principal of which are as follows:

The Pacific Stone Company's quarry, covering the S. ½, N.E. ¼, and the S. ½, N.W. ¼ of Sec. 26, where eleven men are employed.

The Knowles & Hosmer Quarry, covering E. ½, the N.W. ¼, and the N.E. ¼, S.W. ¼ of Sec. 23, where thirty men are employed. During my visit, I saw a cube, laden on the cars for shipment to San Francisco, which was said to weigh fifteen tons.

PETROLEUM.

A great many locations for petroleum have been made in T. 19 S., R. 15 E., covering Sections 8, 16, 17, 18, and 20, and also in T. 20 S., R. 14 E., covering the greater part of three sections adjacent to the lignite mines of the California Coal Company and the San Joaquin Valley Coal Company. The country through Oil Cañon, some eight miles north of Coalinga, seems to be the principal region for mineral oil. Starting from the valley, the first formation encountered is a hard sandstone, dipping at an angle of about 40 degrees to the south and east, when clay shale is encountered, which extends for at least a mile. Here the shale is of a white, argillaceous character, and assumes a semicircular stratification, occasionally intermixed with thin layers of gypsum. The accompanying cut (page 190) represents the foldings.

From here, continuing up the cañon, a series of brown bituminous shales are met, after which hard sandstone is again encountered. The sandstones seem to form the walls or casings of the oil-bearing region, which extends for several miles. Small holes have been sunk at different points through the cañon, and they soon fill with oil and bituminous matter; but no deep borings have been made. In the center of Section 17 a well has been sunk, the depth of which I could not ascertain, from which gas flows. The well has been set on fire, and has been burning for some months.

CHROMITE.

Chromite has been found in many different localities in the county. In Sec. 9, T. 22 S., R. 14 E., there is quite a deposit, where much ore has been mined of a good grade. Chromite is also found in large bunches and pockets in the belt of serpentine which courses northwest through T. 16 S., R. 24 E., and T. 12 S., R. 25 E.; but the ore does not average

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over 45 per cent of chrome, and being twenty-five miles from railroad very little has been done in its development.

IRON.

While in the county great interest was displayed in the deposits of hematite and magnetite iron ore, which report gives as existing near the Minaret Mountains in the northeastern portion of the county. I herewith give a copy of a letter written by Eugene H. Barton, United States Deputy Mineral Surveyor, to C. J. Beck, Esq., of Fresno City, and dated July 27, 1889:

SIR: I have examined the "Magnetic," and "Second Bull of the Woods" Iron Mine, and find it as follows:

Width of vein, three hundred feet exposed; a perpendicular height of fifteen hundred feet of vein showing plainly for two miles in length. Trend of vein southeasterly and northwesterly; standing perpendicular. Character of ore, magnetite, and bright, specular hematite, of extraordinary purity, notable for the entire absence of sulphur. The ore of very high grade, ranging 64, 65, and 66 per cent, in quantity unlimited. These are undoubtedly the greatest mines in existence, and will eventually prove of immense value, as they will produce an iron of unusual quality and fineness. These deposits of iron are situated on the southerly slope of the Minarets, and form one of the largest and finest deposits of iron on the globe.

The quality, according to assays from the State Mineralogist, is unexcelled by any mine on the continent. The quantity in sight is sufficient to build a double track railway around the globe.

A Mr. Nelson, one of the interested parties, handed me several analyses of the ore, made by Mariner & Hoskins, of Chicago, Ill., which I herewith append:

No. 1.		No. 2.	
Iron	66.3	Iron	66.13
Silica	4.57	Silica	4.27
Phosphorus	.128	Phosphorus	.454
No. 3.		**No. 4.**	
Iron	67.20	Iron	62.90
Silica	4.40	Silica	6.35
Phosphorus	.454	Phosphorus	.748

The following is an analysis made of the same iron ore for Mr. Nelson at the laboratory of Rattle & Nye, Cleveland, Ohio:

Iron	66.20
Silica	4.20
Phosphorus	.249
Manganese	.37
Alumina	.54
Lime	2.04
Magnesia	.022
Sulphur	.039
Organic and volatile matter	.34
Titanic acid	None.

On account of the severity of the preceding winter, the snow being very deep, I was unable to visit many places in the county from where extensive finds of gold, silver, iron, and bismuth have been reported.

A feature of the topography and geology of the northeastern portion of the county is the basaltic table mountain, which runs almost parallel with and near to the San Joaquin River. Although this table extends for many miles at intervals, the point where I have had opportunity more closely to examine it was in the vicinity of Auberoy Post Office, in T. 10 S., R. 22 E. Here the table has an altitude above the road from

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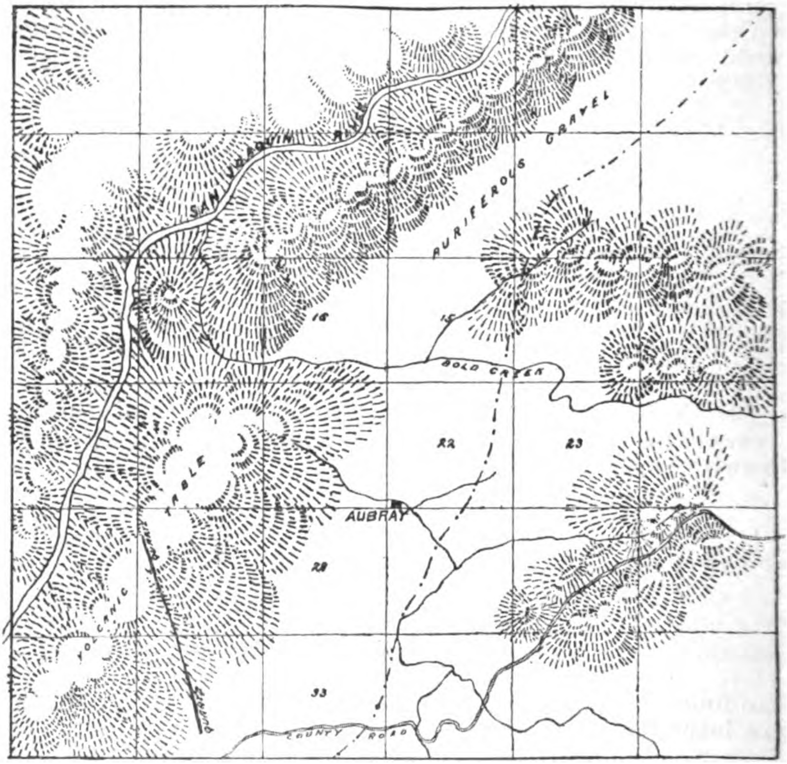
Little Dry Creek of about six hundred feet, and a width on top which varies from a mile to a few hundred feet. The capping rock of this table is basalt, columnar in structure, while underneath is a volcanic ash overlying a bed of gravel, which contains in places some gold, but has not been extensively prospected. The following sketch shows the comparative position of the auriferous gravel and the trend of the basaltic table:



Extending north and east, I am informed that the table continues, in places, to the regions of the Minarets, where much of the surface is covered with pumice, broken into small pieces, and from a foot to several feet in depth. Through this basaltic table, or, better, through the granite underlying it, runs a quartz vein, on which are located several mines. On the south or east side is the Hoxie, or Herron Mine, the course of its ledge being north 15 degrees east, dipping to the west at an average dip of 45 degrees. The fissure has an average width between the walls of from four to six feet, and the wall rocks clearly show the action of heat. While the ledge has but an average of eighteen inches in width, and the fissure from four to six feet, the intervening space is filled with a compact mass of micaceous quartz sand. The mine is opened by a tunnel and two shafts. The tunnel is eighty feet in length and cuts the ledge at right angles. There are two working shafts sunk on the vein, one one hundred and fifteen feet deep, and another one hundred and ten feet deep. There are two shoots of ore determined up

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to the present time, one being one hundred and forty-two feet in length and the other, as far as explored, fifty-two feet. There are three levels in the mine, the longest being one hundred and fifty-two feet. Both Giant and Hercules powder are used in the mine, and about sixty pounds is the amount consumed monthly. Four dollars is the cost of mining per ton. The method of treating the ore is by the "arrastra" process. The company has two arrastras, run by horse power, reducing one and one fourth tons of ore each twenty-four hours, which averages, in free gold, $65 per ton. The sulphurets average about 1 per cent, but none are saved, although tests made show them to be quite rich. The company contemplate the erection of a five-stamp mill. During the year 1890, from January to May, one hundred and thirty-five tons of ore were reduced, yielding $62 50 per ton.

BIG DRY CREEK MINING DISTRICT.

The Big Dry Creek Mining District is situated about twenty-four miles northeast of Fresno City, T. 11 S., R. 22 E., and covers Sections 29 to 36, inclusive. Passing through this section is a belt of slate running northwest, which direction is the general trend of the stratification through this county, the course being, in general, with the direction of the main ridges. This belt is about eighteen miles in length, varying from one to three miles in width, and is in contact with a narrow belt of serpentine on its eastern side. There are but few mines in this district, and at this writing only one on which work is being done, namely, the Confidence Mine.

CONFIDENCE MINE.

The claim is at an elevation of six hundred and sixty-five feet above sea level. It was located in 1874, and is one thousand five hundred feet in length by six hundred feet in width. It is four miles northeast from Academy Station by road. The vein courses northwest and southeast, and dips to the east at an angle of 85 degrees. Its average width is three feet. The mine is opened by a tunnel three hundred and sixty feet in length, and upraises have been made from it to the surface in each of the first two ore shoots, there being three shoots in the mine; a shaft has been sunk in the third shoot from the surface, forty feet in depth. Both walls are of slate. The ore shoots are respectively eighty feet, seventy feet, and fifty feet in length. The greatest vertical depth reached by the working tunnel is one hundred and fifty feet from the surface. The tunnel is well timbered with round pine for two hundred feet of its length. The explosive used is Hercules powder, and but very little of it is consumed, as the ground is quite soft. The cost of mining per ton does not exceed $1 50. About one thousand seven hundred tons have been milled, and have averaged $9 per ton. The mill is a five-stamp mill, situated about one and one half miles by road from the mine, and is run by a sixteen-foot overshot wheel, with two and one half feet face. The ore contains about one half of 1 per cent sulphurets, but none have been saved. The stamps are of six hundred and fifty pounds weight. The drop is six inches, and the stamps drop eighty-five times per minute, crushing one ton per stamp every twenty-four hours. The height of the discharge above the dies is five inches. The screens are of brass

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feeder is used. About 90 per cent of the gold recovered is saved in the battery, and 10 per cent is the product of the outside plates. The average per cent of sulphurets is four, valued at $150 per ton. The sulphurets are concentrated on two Triumph concentrators at a cost of about 10 cents per ton of ore. There are eleven men employed in the mine; of these, seven are Chinese. The white men receive $3 per day, and the Chinese receive $1 50 per day. In the mill three men are employed, receiving an average of $3 50 per day, and one man outside receives $2 50 per day. Two cords of wood are consumed every twenty-four hours. It is oak wood, and costs $5 per cord delivered.

Altitude	2,150 feet.
Length of ore shoot	800 feet.
Vertical depth reached in mine	350 feet.
Character of walls	Slate.
Kind of powder used	Safety-nitro.
Character of ore	White quartz, with sulphurets of iron and galena.
Character of works	Huntington mill.
Capacity of mill in twenty-four hours	12 tons.
Size of screens	No. 9 slot-punched.
Width of sluice plates	15 inches.
Length of sluice	12 feet.
Kind of feeder	Challenge.
Percentage of gold recovered in battery	90 per cent.
Percentage of gold recovered on plates	10 per cent.
Number of men in mine	11.
Number of men in mill	3.
Number of outside men	1.
Total number of employés	15.
Average wages in mine	$3.
Average wages in mill	$3 50.

THE MOUNTAIN VIEW MINE.

This mine is situated about one mile east of the town of Fine Gold, in Sec. 6, T. 9 S., R. 22 E., M. D. M. The elevation of the principal works is twenty-three hundred feet above sea level. It was located in May, 1880, by Harlow & Stevens, and, with its extension, which is called the Banner Mine, it having been purchased by the present owners, the claim is three thousand feet in length by six hundred feet in width. The vein courses north 30 degrees west, and dips to the east at an angle of 60 degrees, and its width averages thirty-six inches. The vein has been opened by four tunnels. No. 1 tunnel is thirty feet from the surface, and runs south on the vein seventy feet. Below No. 1, at a vertical depth of twenty feet, No. 2 tunnel has been run thirty feet, its mouth being fifty feet in a horizontal line from the mouth of tunnel No. 1, in a northerly direction. No. 3 tunnel is one hundred and twenty-five feet below No. 2, and is one hundred and fifty feet long. No. 4 tunnel is two hundred and twenty-five feet below No. 3, and is two hundred feet in length. The formation of the foot wall is micaceous gneiss, and the hanging wall is a metamorphic slate. The tunnels are not timbered, except about one hundred and seventy-five feet of No. 3 and one hundred feet of No. 4, and their dimensions are six feet in height by five feet on the bottom in the clear. An average of one and one half feet has been made in running by each shift of ten hours. There are three ore shoots in the mine, one of seventy-five feet and one of one hundred and fifty feet.

The length of the third shoot, which is tapped by No. 4 tunnel, has not been decidedly determined, although, as far as run on, it is one hun-

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been graded by the company one and one half miles at a cost of $300. Ore is transported from the mine to the mill—which is a Bryant roller mill of eighteen tons capacity—at a cost of 35 cents per ton. Steam power is used for the reduction of the ore, furnished by a twelve by twenty-four-inch horizontal engine, with a forty-eight-inch tubular boiler sixteen feet long. No. 6 slot-punched screens are used in the mill, and aprons covered with silver-plated copper, five feet in width by eight feet in length, are in use. From these aprons the pulp is run over sluices also covered with plate, which sluices are thirteen inches wide and sixteen feet long. A Hendy Challenge feeder is used in the mill and two Garnier concentrators. Of the gold recovered, 70 per cent is found in the mill and 30 per cent on the outside plates. The ore is quartz, containing iron pyrites and galena, and sometimes small quantities of sphalerite (zincblende). Assays from these ores have shown at times as high as one thousand six hundred ounces of silver per ton and $46 in gold. About 3 per cent of sulphurets are contained in the ore, which have averaged in gold $216 per ton, and in the neighborhood of twenty ounces of silver. Twelve miners are employed in the mine, receiving an average of $2 50 per day. In the mill three men are employed, receiving the same wages, and two outside men, receiving $2 per day. Two and one half cords of oak wood are consumed per day, at a cost of $3 per cord, delivered at the works.

Altitude (aneroid reading)	1,500 feet.
Number of ore shoots	3.
Number of tunnels	4.
Average length of tunnels	530 feet.
Vertical depth reached	400 feet.
Character of hanging wall	Porphyry.
Character of foot wall	Granite.
Kind of powder used	Giant.
Cost of mining	$1 75 per ton.
Cost of tunnel per foot	$4.
Number of feet of tunnels timbered	320.
Kind of timber	Round pine.
Cost of timber	5 cents per foot.
Length of road built	1½ miles.
Cost of transportation of ore	35 cents per ton.
Character of ore	Quartz, with sulphurets of iron and galena.
Character of mill	Bryant roller, 18 tons capacity.
Size and character of screens	Slot-punched, No. 6.
Dimensions of apron plates	5 by 8 feet.
Length of plates in sluice	16 feet.
Width of sluice	13 inches.
Kind of concentrator	Garnier.
Percentage of gold recovered saved in mill	70 per cent.
Percentage saved on plates	30 per cent.
Percentage of sulphurets	3 per cent.
Number of men in mine	12.
Number of men in mill	3.
Number of men outside	2.
Value of sulphurets	$200 to $500 per ton.
Average wages in mill	$2 50 per day.
Wages in mine	$2 50 per day.
Outside work	$2 per day.
Cost of wood	$3 per cord.
Quantity of wood used	2½ cords per day.

LAST CHANCE MINE.

This mine is situated in Sec. 14, T. 8 S., R. 21 E., about five miles by road from the camp called Coarse Gold Gulch. It is the property of two experienced miners, Messrs. Rhule & McKenzie, who have owned and worked it since its location by themselves in the year 1880. The

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dimensions of the claim are four thousand six hundred feet by six hundred feet, and it lies on the east side of Upper Fine Gold Gulch, and is nearly twenty miles due east from Raymond, the terminus of the road running from Berenda, whence its supplies are all hauled at a cost of 75 cents per one hundred pounds.

The vein courses northeast by southwest, and dips to the east, making an angle with the horizon of 40 degrees. It has an average width of forty inches. The hanging wall is a quartzite, mixed with talcose slate, and the foot wall casing changes to a talcose slate. Between the walls and the vein is an argillaceous shale, varying in thickness from two inches to fourteen inches. The character of the ore is quartz, with pyrites of iron and galena, containing occasionally some sphalerite (zinc-blende). The working of the mine and the extraction of the ore is being done through a series of four tunnels, the uppermost of which is run north on the vein four hundred feet, and its face is eighty feet below the surface. The vein in this tunnel has been almost entirely stoped to the surface.

No. 2 tunnel is one hundred feet below No. 1, and has been driven in six hundred feet. At about four hundred feet from its mouth an upraise has been made connecting it with No. 1, which gives a good circulation of air. No. 3 tunnel is one hundred and seventy-five feet below No. 2, and is six hundred feet in length. The ore shoots dip to the north, away from the mouths of the different tunnels, and No. 2 tunnel has only now fairly reached the pay shoot, from which the owners expect much good ore. No. 4 tunnel is fifty feet below No. 3, and has been run only a short distance, and for the present has been abandoned. Three shallow shafts have been sunk on the property, two at the apex of the hill close to each other, and in about a line with the face of No. 1 tunnel. They both show ore. During my visit, a small shaft was being sunk on the vein about eight hundred feet southeast from tunnel No. 4, and had attained a depth of twenty feet. A ledge of three feet in width shows well in the bottom, and from tests made in the mill averaged $20 in free gold. The ore here carries an average of 20 per cent of sulphurets of iron and galena. Both Nos. 1 and 2 tunnels are timbered their entire length, and No. 3 is timbered for three hundred and forty feet with round pine timber, which costs 6 cents per lineal foot. The flow of water from No. 2 tunnel is about three miner's inches, while No. 3 has but one half that amount. Giant powder is the explosive used in the mine. Lumber is delivered at the mine for $27 per thousand feet. A road has been built by the owners five miles at a cost of $1,200. The ore is transported from the mine to the mill by wagon at an expense per ton of 25 cents. The mill is on the northwest fork of Fine Gold Creek, on its north bank, and is of ten stamps, weighing nine hundred pounds each, dropping ninety drops per minute. The height of the discharge is five inches, and an average crushing of twelve tons in twenty-four hours is the amount of ore reduced. The shoes and dies used are chilled steel, costing 10 cents per pound, one set of which lasts for crushing one thousand four hundred tons of ore. The battery screens are brass wire, both fifty and sixty-mesh being used, according to the character of the ore. Dodge's automatic feeders are in use in the mill, and a Blake ore crusher. The aprons are four feet in width by two and a half feet in length, and empty into sluices two feet wide by eight feet long, and are all covered with silver-plated copper plates. Eighty per cent of the gold recovered is saved

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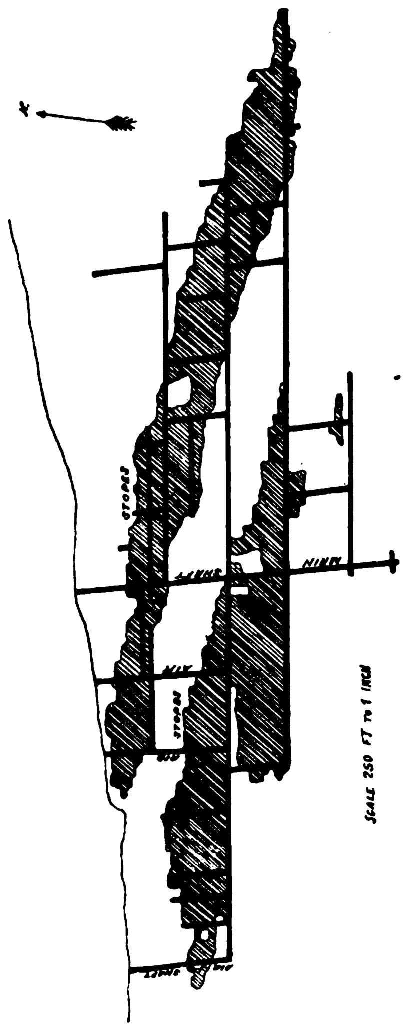
foot wall. The mine has been opened by an incline shaft sunk in the foot wall and vein to a depth of five hundred and fifty feet. Its dimensions are five by eight feet in the clear, timbered with sawed yellow pine, six by eight inches in size, costing $25 per thousand feet. The cost of the incline shaft has been $15 per foot. From this incline have been run eight levels, which are one hundred and sixty, two hundred and twenty, three hundred, five hundred and sixty, one thousand two hundred and ten, one thousand two hundred, three hundred and twenty-five, and twenty feet in length, respectively. The levels have been connected by a series of upraises for ventilation, and from the third level to the surface of the west side of the main shaft are three air shafts, respectively two hundred and sixty, two hundred and fifty, and two hundred and forty feet in depth. The ore shoots are two in number, pitching to the east, quite flat, and lying parallel with each other, separated by poor vein matter, about an average of one hundred and thirty feet apart. In No. 1, or the upper shoot, stoping has been done to a great extent, and stopes have been driven in one continuous line three hundred and twenty feet in length. In the second, or bottom shoot, on No. 6 level, stoping has been driven in one continuous line five hundred and ninety feet in length. Seventy-two thousand gallons of water are handled every twenty-four hours by three pumps—one six-inch Cornish plunger and two jackhead pumps. The kind of powder used is Giant, and about one pound of it is used to the extraction of one ton of ore. The cost of mining ore is $2 per ton. The character of ore is quartz, with pyrites of iron, and has averaged about $10 per ton in free gold. There is a twenty-stamp mill, of one thousand-pound stamps, on the mine, which, under a six-inch drop, are dropped eighty times per minute. The discharge is six inches high, and two tons of ore are crushed per stamp every twenty-four hours. Chrome steel shoes and dies are used, and cost 8½ cents per pound. No. 9 slot-punched screens are the kind used, the screen frames being divided into three parts to each battery of seven inches in width by seventeen inches in length. The aprons are four feet in width by four feet in length, and there are fourteen feet of sluice to each battery, fourteen inches wide, all covered with



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silver-plated copper plate. They are given an inclination of one and three quarters inches per foot. The mill is supplied with four Challenge feeders. About 60 per cent of the gold recovered was saved in the battery, and 40 per cent on the outside plates. Eight Frue concentrators are in the mill. The sulphurets averaged $150 per ton in gold, and twenty ounces of silver per ton.

The plant has a roasting furnace of three tons capacity. The mine has employed thirty-five men, and seven men in the mill, with two outside. Wages averaged $3 per day in the mine, and $4 per day in the mill; outside labor being paid $2 50 per day. A Hamilton Corliss engine, ten by thirty-inch cylinder, with a horizontal tubular boiler, fifty-two inches in diameter by sixteen feet in length, supplied the mill with power. Hoisting was done by means of a double vertical hoist, nine by ten-inch cylinder, steam supplied to it by a horizontal tubular boiler forty inches in diameter by fourteen feet long. Seven cords of wood was the daily consumption, the cost being $4 75 per cord.

In this district are also the mines D'Or de Quartz Mountain, Texas Flat Mine, Flying Dutchman Mine, Crystal Spring Mines, Sullivan Mine, Rattlesnake Mine, Kings Gulch Mine, Victoria Mine, and several others, all of which have been worked to some extent, and some are now being prospected, while others, from various causes, are not now being worked.

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HUMBOLDT COUNTY.

By ALEX. MCGREGOR, Assistant in the Field.

Humboldt County contains three thousand five hundred and ninety square miles, or two million two hundred and ninety-seven thousand six hundred acres of land. Its length from north to south is one hundred and eight miles, and it has an average width of about forty miles, and one hundred and seventy-five miles of meander tide-water line. It is three times as large as the State of Rhode Island; one and one half times as large as Delaware; nearly as large as Connecticut, and one half as large as Massachusetts.

The county is watered by innumerable rivers and streams, and is never troubled with drought or extremes of heat or cold, its mean annual temperature ranging from 52 to 60 degrees. The annual rainfall is about thirty-five inches.

The soil of the bottom lands and on the hills next the coast is black; that on the bottoms is of a sedimentary composition and somewhat argillaceous, while that on the hills rules more of a sandy loam. The soil on the interior hills is composed of disintegrated rock, mixed with organic matter and decayed vegetation.

INDUSTRIES.

Lumber.

This industry has been the principal one since the settlement of the county, and has increased gradually until it has assumed very large proportions. The lumber product of the county for the year ending December 31, 1889, shows as follows:

Lumber, feet	126,957,510
Shingles	261,821,650
Shakes	17,057,919
Posts	1,924,151

A detailed list of the output of the several mills will be found herewith.

It is a fair estimate to state that there are five hundred thousand acres of redwood still standing in the county, and the same will average from fifty to one hundred thousand feet of marketable lumber to the acre. Most of the timber land is held in large tracts by the various mill owners and by syndicates. The timber runs through the county from north to south, in an irregular belt, averaging some fifteen miles in width, leaving an open margin along the coast of from two to ten miles, though at some points it extends entirely down to the ocean.

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Farming.

Owing to the formation of the county, Humboldt is not a large grain-producing section. The assessment roll for 1889 shows that upwards of fifty-six thousand acres were sown to grain and thirty-five thousand six hundred acres were devoted to hay.

Potatoes are largely grown and noted for their excellent quality; over fifty thousand sacks are exported yearly.

Fruits.

The section best adapted to this industry is along Eel River, where the climate is very favorable. In this section are raised apples, peaches, pears, apricots, prunes, and grapes; all of excellent quality. The number of fruit trees growing is estimated at upwards of forty-nine thousand.

Coal.

The finds of coal in the county were reported in the Seventh Annual Report of the State Mineralogist, and are located as follows:

1. Eureka.
2. On Maple Creek, three miles from Mad River.
3. Two miles north of Arcata; half mile from Jolly Giant Mill.
4. On the upper Mattole, on Mr. Thos. Rudolph's place; Secs. 11, 12, 13, and 14, T 3. S., R. 1 W., H. M.
5. On the main Eel River, two miles below Alder Point, on Wm. Wood's place.
6. On Jacoby Creek.
7. On Larribee Creek, Sec. 26, T. 1 S., R. 4 E., H. M.; also, Secs. 2, 3, 10, and 11.
8. Across Eel River from Eagle Prairie, in the bluff.
9. On the Van Duzen, three or four miles above Bridgeville.
10. On the Van Duzen, opposite the Cooper place.
11. On the South Fork of Eel River, one mile north of Garberville.
12. On Bear Creek, one mile east of Garberville.
13. On Panther Gulch, tributary of the east branch of South Fork of Eel River.
14. On Buck Mountain Gulch, tributary of east branch of South Fork of Eel River.
15. On the east branch of South Fork of Eel River, on the Ray Ranch, Secs. 32, 33, 34, and 27, T. 4 S., R. 4 E., H. M.
16. On the Hoopa Indian Reservation.

And are fully described on pages 187–188 of the report mentioned above.

Mining.

The hydraulic mines in this county were fully described on pages 216 to 223 of the Eighth Annual Report of the State Mineralogist, and since that time there have been no new developments.

At Red Cap Bar, situate in Sec. 29, T. 10 N., R. 6 E., H. M., there is a large cropping of copper ore, and although considerable work has been done there, up to the present time the ledge has not been found.

There are deposits of mica and a ledge of building stone located about eight miles north of Eureka, and about one mile east of Humboldt Bay.

In the city of Eureka, in S. ½ of S.W. ¼ of Sec. 23, T. 5 N., R. 1 W.,

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H. M., there is a large deposit of clay, which is used for the manufacture of brick. The brick has been extensively used in building, and is said to be of superior quality. The bed is covered with clay mixed with fossils.

In fractional T. 2 N., R. 3 W., H. M., and about nine miles southwest of Ferndale, there is a large deposit of mineral paint of a superior quality. It has been considerably used in Ferndale and the neighborhood for the painting of roofs, with good results. There is a deposit of a similar nature in Sec. 15, T. 6 N., R. 1 E., H. M., about half a mile west of Vance's Lumber Mill.

A further and considerable deposit of this mineral paint is found near Garberville, in Sec. 24, T. 4 S., R. 3 E., H. M., and is used in the neighborhood for similar purposes to those above mentioned.

Petroleum and Asphaltum.

The petroleum and asphaltum in this county were exhaustively reported upon in 1887, on pages 195 to 200 of the report of the State Mineralogist for that year. There have since been no new developments in that direction.

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Modoc, Lookout, Minietta, and Confidence are located on the east slope of Lookout Mountain, twelve miles southeast of Darwin.

THE DEFIANCE MINE,

An early location, has been opened by an inclined shaft three hundred feet deep, and four tunnels, whose aggregate length amounts to four hundred and fifty feet; considerable of the ground has been stoped. The ore, an argentiferous galena, with some carbonates, carries 50 per cent lead with about sixty-eight ounces of silver and some gold. Until 1865, the most of it was reduced in the company's smelter; after that the ore was assorted, and the richer part sent to the Selby Works, near San Francisco. Under this system, four fifths of the ore in bulk and nearly half in value has been left in the mine or has gone on the waste dump. Not over a foot of ore is broken out of a ledge averaging twelve feet in thickness. With a view of reducing this loss, a jigging machine has lately been brought in and set up for concentrating the low grade ore on the dumps, and the same quality of ore that may be taken out of the mine hereafter; these concentrates to be brought up to a value of $120 per ton; this, if shipped to the Selby Works, would leave a net profit of $60 per ton. Enough of this jigging ore is in sight to run a thirty-ton smelter for a year or more. It is expected that other companies will adopt this system of concentration, which will work a great change all around, inasmuch as it will furnish employment for more men, and increase the revenues of the companies.

The owner of this mine, besides expending large sums in improving and developing it, has purchased the system of waterworks, whereby the town and mines are furnished with water, and has enlarged them until the former inadequate supply has been rendered ample. This water, which is derived from a spring seven miles distant in the Coso Mountains, was brought in at an original cost of $45,000. Through the substitution of larger pipes the quantity of water delivered has been doubled.

THE LUCKY JIM MINE.

The Lucky Jim Mine, three miles northerly from the Defiance, occurs in granite; in the neighborhood a limestone is found. On the vein a vertical shaft three hundred and twenty-six feet deep has been sunk, and an aggregate of four thousand feet of ground drifted and stoped. The steam hoisting plant on the shaft has been burned down lately. The ore consists mainly of galena and carbonate of lead, carrying an average of fifty ounces silver per ton and 40 per cent lead, there being but little gold. Up to 1885 the assorted ore was smelted in the local smelter; since that time it has been shipped or sold to outside smelters. The total value of the ore taken from this mine has been estimated at $1,250,000. The output of the Christmas Gift Mine has also been considerable. Both of these mines are now worked on a limited scale, notwithstanding the ore exposures in both are large and much of them of a good grade. On the Pluto little more than assessment work has been done, though the surface indications are favorable. Lying a short distance north of Darwin are the Kerso, Independence, and Copper Grand Mines, on all of which some work has been done. From the Kerso, on which a five hundred-foot tunnel has been run, some good silver lead ore has been extracted. The

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In the Wild Rose District to the west, there are barely enough people to keep the four-stamp mill and a few arrastras in operation. As there are several good mines known to be here, owned by men of enterprise, it is thought that the larger mill, erected several years ago in the district, will soon be started up, and a general awakening of the mining industry follow. In the Coso District, still farther west, much the same state of things prevails. A dozen miners, mostly Mexicans, running arrastras on the tailings, as also on the partially decomposed dump piles, represent the mining population of Lee District, which lies to the north. Although many of the ledges here show much strength, and appear to be well stocked with hornsilver, galena, sulphuret of silver, and carbonate ores rich in both gold and silver, the district has been on the wane, nor does it show present signs of recuperation. Being pretty thoroughly chloridized, this material now being handled by arrastras, could probably be worked to advantage by the leaching process.

At Snow's Cañon, a locality lying to the south of Coso, where a mill was put up in 1883, and which was then the scene of much mining activity, nothing beyond assessment work is now being done. The district abounds with deposits of gold, silver, copper, and lead; platinum has also been found there; still nothing can be done at present, chiefly on account of lack of timber, the nearest forests being on the Panamint Mountains, twenty miles away to the east. The railway is still farther off, with long waterless stretches intervening.

All the brilliant prospects and the fond expectations of the Chicago Company, who, seven years ago, erected a mill and roaster down in the Saratoga District, occupying the southeastern angle of the county, have vanished. The reduction works and the mines, on one of which, the Ibex, a shaft was put down to a depth of eighty feet, are still there, with a single individual who looks after them. There are some rich mineral deposits in this district, but the ore, a sulphuret of silver with copper, requires roasting, and fuel and water are either totally lacking or very scant, and not less than twenty miles away. Telescope Peak is entirely deserted, and the entire Death Valley region is in much the same condition, being only occasionally visited by prospectors, none of whom have succeeded in finding the rich gold deposits supposed to be there. Practically the whole country east of the Panamint and the Inyo Mountains has been abandoned. While these remote and desert-girt districts are so forsaken, those to the west of these mountain ranges have made considerable advances in mining.

CERRO GORDO DISTRICT,

Lying on the western slope of the Inyo Range, has experienced some mining activity during the past twelve months, more so than during the preceding ten or twelve years. After a successful career, extending from about 1873 to 1879, the Union Mine in this district suffered a collapse from the exhaustion of its rich ore bodies. During this period of bonanza, the output of silver bullion here averaged one and a half million dollars per annum. The ores, consisting of carbonates and sulphides of lead rich in silver, being easy to reduce, the cost of extraction was moderate, and large profits were realized.

After entering into "barrasca," but little was done with the mine until

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to run one hundred stamps; the surplus is used on one hundred and sixty acres of land lying adjacent to the mill and owned by the company. The mine, which is situated about sixteen hundred feet above the valley, has been opened by a shaft sunk on the vein to a depth of four hundred feet. Five levels have been driven, of which the longest is three hundred feet. The vein has an average thickness of six feet. Twelve inches of the vein matter next the hanging wall consists of ore carrying 40 per cent of lead, and an average of seventy ounces of silver to the ton. A carload of this ore sent to the old Melrose works near Alameda sold for $95 per ton. The gold ore is stored at the mine until it can be reduced in the company's mill.

The Hirsch Mine, adjoining this property, has been worked to some extent, yielding a high grade copper and also galena ore.

The San Carlos Mine, lying in the foothills of the Inyo Range east of Owens River, supposed to be the earliest location made in this section of country, was like the rest tributary to Independence before the advent of the railroad. It was opened by a tunnel several hundred feet in length, from which large quantities of high grade ore were taken that were shipped for reduction, yielding over $100 per ton in silver, 12 per cent copper, and 30 per cent lead, with a small percentage of gold. Work has been intermittent on this mine, but the recently improved prices of silver, lead, and copper have induced the owners to push operations more vigorously. The Confidence and the Chalfant Claims are promising prospects located near the San Carlos.

THE ALABAMA DISTRICT

Lies eight miles north of Independence, close under the Sierras, and on either side of Alabama Cañon, along which, with its branches, some placer mining has been done years ago. Later, ores of gold and copper were found and worked for the gold in arrastras. Only a small percentage could be saved by this method and the claims were dropped.

FISH SPRING DISTRICT

Is north of the Alabama, occupying an outlying ridge separated from the main Sierra and flanked by low hills. Traversing this ridge are numerous small, but generally rich gold-bearing quartz veins, the ore from which is being worked by arrastras run by water power situated two or three miles below. Flowing from the mountains near by are two large streams furnishing water enough to drive several hundred stamps the greater part of the year. The veins are mostly worked by their owners on a limited scale, the ore being rich but in small lots. A number of these properties might be combined for large and more profitable operations.

MARBLE QUARRIES.

San Francisco, April 7, 1890.

Hon. William Irelan, Jr., *State Mineralogist*:

Dear Sir: On July 26, 1888, the writer visited and examined the Inyo Marble Quarries, and as the result of such examination wrote the notice of them which appears on page 229 of the Eighth Annual Report of the State Mineralogist.

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steep mountain side, taking chances of their catching some underlying knob of solid rock on the way, and then overturning and bounding, as they sometimes do, to the bottom, thus further breaking up, to a greater or less extent, both themselves and everything else which happen to lie in their way.

It of course follows that no large blocks can now be obtained from the upper quarry except such as are split and dressed at the foot of the mountain out of much larger irregular ones originally blown from the quarry, and then slid or rolled down the mountain.

Under these circumstance there happened to be lying at the foot of the mountain, on March twenty-seventh, a few blocks from the upper quarry, roughly dressed into shape, which I measured as follows:

6 feet by 4 feet by 3½ feet=84 cubic feet.
8½ feet by 3 feet by 2½ feet=63¾ cubic feet.
7 feet by 4 feet by 2 feet=56 cubic feet.
5 feet by 4 feet by 2½ feet=50 cubic feet.
6 feet by 2 feet by 2 feet=24 cubic feet.

Every one of these blocks was pure white, fine-grained, very uniform in texture, and, so far as could be seen, without a crack or flaw. The largest one particularly, containing eighty-four cubic feet and therefore weighing nearly fifteen thousand pounds, was a most beautiful block, and if as good and sound throughout as it looks on the surface, would make a fine piece of statuary marble.

I conclude that where such blocks as these have been obtained under such circumstances, from such a little hole as that upper quarry is, it is more than probable that on further development this quarry can furnish perfectly sound blocks of any size that can be handled. And if this prove true, the quantity is inexhaustible, for the whole southwestern flank of the mountains for a considerable distance there is made of marble.

The present openings furnish almost exclusively white marble; but only a few hundred yards distant from them there are very heavy masses of a grayish, streaked and mottled marble, filled with dendritic markings, which take a fine polish, and is also a hard and handsome stone. The "ground mass" of this mottled marble varies somewhat in color, being sometimes very white; while in other places it is more or less tinged with varying light shades of yellow and green. It also is generally fine-grained and compact, and can probably be obtained in blocks of very large size, though it is not yet sufficiently opened up to satisfactorily prove its condition.

At another locality, which I did not visit because it was too far up in the mountains, and scarcely any work has yet been done upon it, there is a distinctly yellow marble, of which I saw some handsome fragments, and which the Superintendent of the works, Mr. M. V. B. Bronson, believes can also be obtained in large, sound blocks.

In other places there are other colors, especially such as range from white, through numerous varying shades of gray, to black. But these are yet undeveloped.

As to the so called "onyx marble," though there is considerable of it in some places here, I could not learn that any large blocks of it had ever yet been obtained.

In the present state of affairs it will unavoidably require the expenditure of some time, as well as money, to further open up these quarries,

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the Tulare Valley south of T. 24. S., M. D. M., and included in the mountain ranges encircling the head of the valley, having a width east and west of forty miles, and a length north and south of fifty miles, giving it an area of two thousand square miles. The margins of the valley are plains rising to elevations of from one thousand to one thousand five hundred feet, to the base of the mountains. In the central portion of the southern end of the valley are Kern and Buena Vista Lakes, the first formerly covering an area of thirteen square miles, and the other twenty-five square miles, receiving the waters of Kern River through a large number of sloughs, creating an extensive delta of marsh lands.

This section has a drainage by Buena Vista Slough to Tulare Lake, thirty-five miles north by west. Formerly the entire valley was a region of desert and marsh, but about seventeen years ago there was commenced a system of reclamation by irrigation and drainage that has made a great portion of the waste land the most productive in the State. By the drainage and the diversion of the water of Kern River the lakes have become nearly dry, and much of their former beds are under cultivation.

THE RIVERS.

Kern River and Poso Creek are the principal streams of the county, Kern being the third in magnitude of the rivers flowing from the Sierra Nevada south of the Sacramento, the two larger being the San Joaquin, flowing to the ocean, and Kings River, flowing to Tulare Lake.

This river rises among the highest peaks of the Sierra Nevada, in the northeastern part of Tulare County, having two large forks flowing southwesterly one hundred miles, thirty-five miles of which are through the grandest cañons of the Sierra. It enters the valley near Bakersfield, then flowing westward divides into many channels, forming an extensive delta known as Kern Island. The river has a catchment area of two thousand three hundred and eighty-three square miles of the high Sierra, giving it a flow as it debouches on the plain of from two thousand seven hundred to twenty thousand cubic feet per second, in the time of floods.

From this stream thirty large irrigating canals have been taken. The largest of them is the Calloway Canal, which taps the river one and a half miles northeast of Bakersfield, where the river is four hundred and eighty feet wide. This canal leads northwesterly a distance of thirty-two miles, is eighty feet wide on the bottom and one hundred and twenty feet wide on the top, has banks seven feet high, and usually flows six feet, and has a grade of eight tenths of a foot per mile. It commands an area of two hundred thousand acres.

Sixty-five distributing ditches, from eight to twenty feet wide, are taken from it, having an aggregate length of one hundred and fifty miles.

Kern Island Canal is taken from Kern River about two and a half miles northeast of Bakersfield, and flows through the city. It is forty-eight and a half feet wide at the bottom and four feet deep. At Bakersfield this canal has a drop of twenty feet, where it furnishes power for a large flouring mill.

It was commenced in 1870, and is one of the oldest of the system of irrigating and water-power canals in Kern County.

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Southwest of these are the similar valleys of the Tejon, Las Uvas, San Emigdio, Zapatero, Pastoria, Palita, Castera, and La Siebra.

POSO CREEK.

Poso Creek has its source in many branches high up in the Greenhorn Mountains, the lofty spurs of the Sierra, rising in T. 25 S., R. 30 and 31, flowing southerly some twenty-five miles, then westerly and northwesterly until it sinks in the great valley in T. 25 S., R. 23 E, after a winding course of seventy-five miles. This stream falls very rapidly out of the mountains, at two hundred feet per mile, discharging its waters very quickly and becoming low early in the season. It has a watershed of four hundred and sixty-eight square miles. Poso Irrigation District has been formed and a system adopted for impounding the waters of the stream, and the construction of retentive canals for the irrigation of the land of the district..

Mr. Emmet Barker, Chief Engineer of the district, proposes to construct three reservoirs and the necessary canals, at a cost of $193,434, at the present time sufficient to irrigate about sixty thousand acres of land. The system completed will irrigate one hundred thousand acres. Some of this territory is now Government land. The name of the creek has been written in several different way, as Posey, Posé, Poza, and Poso, the latter being the Spanish for a well of water.

The village of Poso is on the bank of the stream where crossed by the Southern Pacific Railroad.

MINERALS.

As previously stated, the mines of the Sierra Nevada were exhaustively treated upon in the report of the State Mineralogist for 1888. Since then there have been but few developments, although mines of wealth are known. The great extent of the mountain region and the limited time allowed forbid a thorough exploration during the present season.

GYPSUM.

Captain W. A. Fauntleroy, a pioneer navigator of the coast, now a resident of Bakersfield, is engaged in mining gypsum from a deposit situated in the foothills of the Sierra Nevada, on both sides of Cottonwood Creek, five miles northwest of Pampa Station, on the Southern Pacific Railroad.

The gypsum mines are located on Secs. 21, 27, 28, and 29, T. 29 S., R. 30 E., M. D. M. The gypsum, as explored, is from twenty inches to five feet in thickness, and lies on a bed of marl of unknown depth. There are three companies formed to mine the gypsum on this land, viz.: the Pampa Gypsum Mining Company, the Cottonwood Company, and the Gypsum Mining Company, owning one hundred and sixty acres each.

The mineral appears in three forms, or strata, in the bed; an upper crust of two or three inches being quite hard, and purer than that beneath, which is almost as easily removed as a bed of sand. This bed in some places forms the surface of the ground, but generally is thinly covered with an unproductive soil. It is mined and sacked, and hauled to Wade

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property is on Sec. 20, T. 11 N., R. 23 W., S. B. M., about thirty miles southwest from Bakersfield.

In Sec. 18, T. 11 N., R. 24 W., S. B. M., are two wells, one eighty-one feet deep, and the other ninety feet, from which three to five barrels flow daily, and from which twenty barrels can be pumped. One of these is the property of the Sunset Oil Company and the other of Mr. Blodgett; the latter is at the mouth of the Paleta Cañon. Two miles west of Blodgett's, in Paleta Cañon, are springs of salt water and oil.

In T. 30, 31, and 32 S., R. 21 and 22 E., M. D. M., and extending into T. 11, S. B. M., are vast beds of sulphur.

In this same region gypsum of the purest quality, suitable for plaster of Paris or for fertilizing, is reported in banks of one hundred feet in thickness.

Also, a gray sandstone, which is easily quarried in blocks two to three feet in thickness and fifteen or twenty feet long, and which dresses well for building stone. This is upon Government land, and but a few miles from the surveyed route of a railroad that is expected soon to be constructed.

In Sec. 13, T. 11 N., R. 24 W., S. B. M., is an isolated hill that appears to be a mass of kaolin.

In T. 30 S., R. 22 E., M. D. M., are numerous hot and cold sulphur and mud springs.

ANTIMONY.

In the rough mountains of the extreme southwestern part of the county is the San Emigdio Antimony Mine, which for many years has been worked under the great disadvantage of being distant from modern means of transportation.

This mine is located on a spur of the mountain bordering San Emigdio Cañon, in Secs. 10 and 15, T. 9 S., R. 21 W., S. B. M.

There is a legend that this mine was once worked by the padres of the missionary period.

It was reopened in 1876, by Stephen Baushey, who erected crushing, concentrating, and smelting works on San Emigdio Creek, two miles from the mine and three thousand feet below them. The crusher and concentrator are worked by a small steam engine, and the smelting is done in crucibles. The ore is packed on jackasses from the mine to the furnaces.

The vein is apparently eleven feet wide, running north and south through a high ridge, and dips to the west at an angle of 68 degrees. Four claims have been located on the vein, and United States patents obtained. The claims were located on what appears to have been a break from the vein, following a curved line around the east side of the hill. Later developments show that the main ledge strikes in a direct line through the mountain. The mountain is porphyritic, and the vein has a clay selvedge four inches thick on the foot wall.

The hanging wall is not so well defined. Two tunnels, called the Two Brothers, have been run on the north end, and two, called the Two Sisters, on the south end of the mine. Another is in two hundred and thirty feet, and has struck a body of ore one foot in thickness.

In the fallen ledge, the ore is from two to four feet in thickness, and will average 40 per cent of sulphide of antimony. This is packed to the reduction works.

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LAKE COUNTY.

By W. A. Goodyear, Geologist, and Assistant in the Field.

From the Geyser Springs I ascended the Cobb Mountain. The depth of the Pluton Cañon at the Geysers is not far from one thousand seven hundred feet.

The crest of the Cobb Mountain is in the form of a single straight ridge whose axis lies about east and west magnetic; and the first ridge to the north of Pluton Cañon (the ridge of "Lookout Mountain") is a direct continuation of the Cobb Mountain ridge towards the west. The Cobb Mountain is easily climbed from the Geysers. There is a trail running from the latter place across the ridge to Cobb Valley, which lies at the northeast foot of the mountain. This trail on leaving the Geysers climbs at once to the crest of the Lookout Mountain ridge. This crest it follows for some distance to the east, and then leaves it and winds along the northern slope of the Cobb Mountain, gradually descending towards the valley.

To reach the summit of the mountain we follow this trail till it leaves the ridge, and then we leave it and continue following the crest, aiming always at the highest ground visible towards the east. I estimated the distance by this ridge from the Geysers to the highest point of the mountain at about six miles, and one can easily ride all the way.

The whole of the Lookout Mountain ridge, till we reach the western extremity of Cobb Mountain proper, consists of metamorphic rocks, sandstones, serpentine, jaspers, etc., and the parallel ridges to the northwest of it seemed to be made up of similar rocks, so far as I could judge.

All this mountainous belt, stretching northwest from the Geysers, passing up the western side of Big Valley and Clear Lake, so far as the road which crosses the mountains from Lakeport to Ukiah, via the Blue Lakes, consists of a succession of ridges and deep cañons, generally very steep, and covered with a very dense growth of chamisal, making it a rough and difficult region to penetrate.

The crest of the Cobb Mountain proper is some three miles in length, its highest point being nearest its eastern end. It is entirely volcanic, and heavily timbered, the timber, however, not extending to the west beyond the volcanic crest.

At its western extremity, which is the point at which the Cobb Valley trail leaves the ridge, it rises abruptly for several hundred feet from the Lookout Mountain ridge, and then continues to rise very slowly for something over two miles farther east, to the highest point. A short distance beyond this point the eastern end of the mountain falls off steeply for more than one thousand five hundred feet into a comparatively low saddle, between it and the Harbin Mountain, through which passes the new road from Kelseyville to Calistoga, via Cobb Valley and Locoanomi Valley, and around the east side of Mount St. Helena.

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striking resemblance to the material of the volcanic table land north of Bishop's Creek, at the head of Owens Valley, only its color is light gray instead of pinkish. The inclosed metamorphic pebbles are different in kind, and I saw here no tendency to columnar forms.

At the distance of about two and one half miles from the Toll House, however, we met with serpentine, and from here to Bradford's everything seen in place along the road was metamorphic, the quantity of serpentine being immense and forming a very large proportion of all the rock within this distance, the balance being chiefly sandstone, all of which is too highly metamorphosed to show any distinct stratification.

Continuing on to Guenoc, in Coyote Valley, we made camp some two or three miles beyond; that is, northwest from Guenoc and at the mouth of a little branch of Puta Creek, which comes in from the northeast side of Harbin Mountain.

All the rocks seen in place between Bradford's and Guenoc were metamorphic and chiefly sandstones and serpentine, the quantity of serpentine being very large.

Beyond Guenoc, also, the hills on the south side of the valley appear metamorphic, but the hill immediately north of camp is of unaltered sandstone. This is heavy bedded, and is not sufficiently exposed to exhibit well its strike and dip. Some appearances, however, suggest that the strike is probably nearly parallel with the cañon, and the dip to the north. Just below camp, there is in the bed of Puta Creek a fine exposure of unaltered strata consisting of sandstones and thin-bedded shales, which strike east and west magnetic, and dip 35 degrees north. I found some minute dodecahedral crystals, probably garnets, in a paste of partially metamorphosed argillaceous limestone, in the creek near camp.

From this camp we climbed the Harbin Mountain, all the higher crest of which is densely timbered and volcanic. The form of this mountain also is that of a simple ridge crest, from which long spurs run far southeast to Puta Creek. These spurs are timbered to some extent with scattered oaks, and partially covered with chamisal, and consist entirely, so far as seen, of unaltered or slightly altered sandstones and shales, till we reach the edge of the open timber, beyond which everything is volcanic. Mr. Craven stopped to take his observations from the summit of a little peak on one of these spurs called Mount Esther, while I went on to the crest of the main mountain with the barometer.

Mount Esther is of unaltered sandstone, and the line between this and the volcanic rock passes but a short distance northwest of its summit across the saddle which connects it with the main mountain.

The gap between the Harbin Mountain and the Cobb Mountain is a deep one, even the former mountain rising high above it. Neither the Cobb Mountain nor the Harbin Mountain looked to me, in their form or in the character of their rock, as though they had been built up in any way by materials ejected from craters.

I saw nothing whatever suggestive of a crater upon either mountain, and the character of their rock shows little variety in texture or appearance. They are both nearly straight ridges, and the Harbin Mountain itself is pretty high, while the Cobb Mountain is the highest peak in that whole country.

I think they have both probably been uplifted to the surface, where they stand in the form of massive eruptions, which may have spread to

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It did not seem to have been a whirlwind, as the trees, nearly all of them, lie with their tops to the north.

The volcanic rocks here extend far down the southern slopes of the hills, close to the edge of the valley, and seem to overlie unaltered rocks, into which some of the cañons have been eroded. At one point on the little creek by the Lower Lake road, about a mile from the northern edge of the valley, I noted unaltered sandstones and shales, striking north 80 degrees east magnetic, and dipping 45 to 50 degrees north.

Dr. Cooper, who had been to Lower Lake and then returned via the cañon of Seigler Creek, and across the divide which separates it from the head of the cañon at the mouth of which our camp was, reported that on his way here from Lower Lake he saw much volcanic rock and also serpentine, together with some material of doubtful look between serpentine and semi-obsidian or semi-opal. He also saw sandstones and shales (probably unaltered), and in one place observed a bed of these shales dipping at a high angle with beds of horizontally stratified conglomerate overlying them.

We afterwards traveled to a point of observation at the summit of a high sugar-loaf peak about seven miles southeast of Guenoc, and just south of Round Valley.

The first mass of low hills east of Coyote Valley consists of metamorphic rocks, chiefly serpentine, capped with volcanic rocks.

Most of the hills and ridges in the region about our point of observation seem to consist of metamorphic rocks below, capped with volcanic rocks above.

The sharp crest of the peak we were on is entirely volcanic, its base being metamorphic. The quantity of serpentine among the metamorphic rocks of this region is enormous. It is seen in great irregular bands and patches scattered to a greater or less extent over the hills in every direction. An immense body of it apparently lies in the next high ridge northeast of Puta Creek, stretching up in places nearly two thirds of the way from the foot to the crest of the ridge, subtending from our point of observation an arc of about 40 degrees, *i. e.* from north 30 degrees east to north 70 degrees east magnetic.

All the valleys in this vicinity, so far as seen, are small and very winding and irregular. Their soil is generally good, and they all drain into Puta Creek, which lies to the northeast. The hills about here are not very high, our point of observation being among the highest of all; but they are generally rocky and steep, and the sugar-loaf-shaped peaks seem to be a feature of the country, and are quite numerous.

Almost the only volcanic material seen about here is the dark gray, solid rock, similar to that on the north of Coyote Valley. It caps nearly all the hill tops, and covers their sides with bowlders. I cannot point to any definite locality whence it has come. No craters are to be seen.

On our return we climbed a sugar-loaf peak in the little valley next northwest of Round Valley, and about three quarters of a mile a little north of west from which there is a little lagoon. Our barometer showed this hill to be about three hundred and fifty feet high. It rises from the bottom of the valley, entirely isolated, and is a perfect cone, with a sharp summit. The average slope of its sides from base to peak is about 25 degrees, but the sides are concave, and considerably steeper towards the top than they are below. The hill is entirely volcanic, and the rock

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But it seems more probable now, I think, that the great culminating volcanic mountains here have been uplifted in massive form, and that the crater action has taken place chiefly, if not entirely, at numerous lower points. But then the question at once arises, where were these points? and this question is yet unanswered. If any unquestionable remains of craters can still be found here, they must be few and far between, for I saw nothing which I could recognize as such southwest of Clear Lake, or anywhere to the south of the latitude of Lower Lake.

Nor was any single locality observed whatever, from whence there is any evidence, so far as I could see, that such quantities of lava have issued in any way as would be required to account for the masses of volcanic rock which cover so great a portion of the hills over so broad an extent of country to the east, to say nothing of the difficulty of understanding and accounting for all the positions which these rocks occupy, upon any supposition of their having flowed in broad sheets over the general surface of the country. Indeed, there is but one hypothesis which occurs to me now that seems at all adequate to account for the condition of things existing here, and that is this, viz.: That the volcanic rocks were originally ejected to the surface in the form of dikes, etc., through numerous local fissures and holes scattered all over the country in which they occur; that from these openings thus formed, the lava flowed to a greater or less extent, and in different directions, over portions of the surrounding surface, and that subsequent to that period the country has been probably not only considerably denuded, but also extensively and very irregularly disturbed.

The supposition involved in the last clause does not necessarily imply, of course, any considerable general elevation or depression of the country (though such indeed may have occurred), but only a general disturbance, similar perhaps, in some respects to the breaking up and relegation which sometimes occur with a sheet of ice that covers an expanse of water, the different portions of the original surface becoming here and there irregularly depressed in outline, and more or less tilted up in various directions and at various angles. This is such a disturbance in fact as might have caused an extensive and irregular bending, breaking, and crushing of the stratified rocks, accompanied with the tilting up of many of the lava beds to the positions which they now occupy, and perhaps a breaking of them here and there in such a way as to form irregular lines of bluffs.

It should be noted, however, in connection with this hypothesis, that I know of no evidence, except the single fact of the positions which the volcanic rocks now occupy, to prove that the exceedingly irregular disturbance of the stratified rocks, which seems so general throughout this region, was in reality subsequent in date to the volcanic period. It is, indeed, far more probable, I think, that the greater portion of this disturbance preceded the volcanic eruptions; the rocks probably striking and dipping in various directions beneath the lava as well as elsewhere. But many things seemed to me to indicate a possibility, not to say a probability, that the disturbance may have continued to a greater or less extent throughout the volcanic period, and not entirely ceased until some time after it. I certainly think that the appearances at many points suggest a probability that many of these sheets or masses of volcanic rock have been more or less tilted since their eruption.

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Other facts bearing more or less directly upon this subject will be mentioned hereafter.

I do not offer what precedes, however, as a positive theory at all, but simply as a hypothesis, which so far as my observations go, seems as plausible as any which I can frame to account for the complex facts.

The structure of this region is in many respects anything but simple, and it will need a very minute investigation and classification of its details to settle with certainty a great many interesting questions relating to the *modus operandi* of its formation.

Our next camp was near Lower Lake.

From the camp near Guenoc to the head of Coyote Valley, a distance of about one and a quarter miles, the hills to the north are unaltered rocks. To the south of the northwest portion of Coyote Valley the hills are metamorphic, and consist largely of serpentine. Between Guenoc and Lower Lake the country seems to consist almost entirely of unaltered sandstones, shales, and volcanic rocks, the latter covering nearly all the highest crests. No good exposures were seen here of the strike and dip of the unaltered rocks.

We made camp upon the left, *i. e.*, the north bank of Cache Creek, just above where the Borax Lake road crosses the creek, and something over a mile by the road from the village of Lower Lake.

Between the village and the southeast end of Clear Lake is a little valley with some good land. To the east and southeast also from Lower Lake, within a radius of two or three miles, are two or three little winding valleys with farms, the hills immediately surrounding them being generally of unaltered rocks.

This camp was close to the southeast edge of a broad expanse of volcanic rock, which, stretching westerly along the northern side of Cache Creek, and then northwesterly along the shore of Clear Lake to Burns' Valley extends from thence several miles northeasterly, filling almost the whole area between Clear Lake and two small creeks, one of which runs to Burns' Valley, and the other to Cache Creek. It also extends beyond the former of these two creeks, stretching northeasterly along the south side of Burns' Valley, but does not seem to extend to the east beyond the second creek referred to, which runs to Cache Creek. There is also more or less volcanic matter along the shore of Clear Lake in front of Burns' Valley, and it extends nearly to the end of the mountain spur which separates Borax Lake from Clear Lake. Between Burns' Valley and the lake there is much scoriaceous matter forming low, broad knolls along the shore, but the broad area southeast of Burns' Valley consists chiefly of solid lava, and has a general and gentle slope southwesterly towards the lake, while on its eastern margin it is more or less bluffy.

Portions of this lava show a more or less distinct bedding, but in other places it seems massive, and some of it resembles, more or less, in appearance the rock of Cobb Mountain. There is considerable obsidian in small splinters scattered around the vicinity of our camp. From here, we took the old and now abandoned Sacramento Road from Lower Lake, and followed it to the high summit, which it crosses in the vicinity of Morgan Valley. From this summit of the road we climbed the crest of the high and rather sharp chamisal-covered peak, which is so prominent from all the hills in the country around and east of Guenoc, as being apparently the highest point in the country for a considerable distance south of Cache

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Creek, though in reality one or two points farther east are nearly, if not quite as high. This peak is about five miles a little north of east from Lower Lake, and just northwest of Morgan Valley.

All the rocks seen along the route we followed up to this peak are unaltered sandstones, shales, etc., except some volcanic bowlders noticed in the cañon about half way between here and Lower Lake. These unaltered rocks are generally either very heavy bedded or else poorly exposed. But at one point about a mile southwest of the peak, I noticed the sandstones with beds of pebbly conglomerate, striking about north 50 degrees west, and dipping 30 degrees northeast. This old road follows down the right bank of Cache Creek to a point about two miles from Lower Lake, at the site of an old mill, where the creek makes a short bend to the north, and the road leaves it and follows up the cañon of a little creek which comes in from the east or a little south of east. On reaching the head of this cañon, it climbs obliquely for some distance the southern slope of a great spur which runs to Cache Creek, crosses the crest of this spur and continues easterly along its northern slope, still ascending, till it reaches the summit at a point some half or three quarters of a mile northwest of Geoffrey's place; that is, Willow Springs, and perhaps three quarters of a mile southeast of the peak in question.

At the crest of this peak I made the following notes: A cañon runs from here about north 75 degrees west, and nearly straight some two and a half miles to Cache Creek, which latter here runs northeast. On the other side a cañon running about north 30 degrees west magnetic to Cache Creek passes perhaps three quarters of a mile to our northeast. Along the southeast side of Cache Creek, and between these two cañons, runs an isolated ridge, in which the strata from about north 75 degrees west to north 50 degrees west, and from one and a half miles to two miles off, are well exposed, and strike northwest and dip southwest at a gentle angle, probably of from 20 to 25 degrees. These strata have a slightly greenish tinge, but are probaby sandstones, little, if at all, altered.

In the next ridge to our northeast, which starts from a point on Cache Creek bearing about three and a half miles north 2 degrees east, and runs southwest to its culminating point, a peak about as high as this one, and which bears about five miles north 85½ degrees east, there is a great quantity of rock distributed all along which looks green enough for serpentine, and the other rock exposed here and there in the same ridge looks generally metamorphic, while a few isolated patches certainly look volcanic. The mountain which bears some four miles south 59 degrees east is capped with volcanic rock.

This point of observation is entirely of unaltered sandstone to the peak along the spur up which we climbed it; but on other sides of this same mountain, lower down, are green patches which may be serpentine.

In all directions, but especially to the north, patches of this green rock are visible, and its quantity about this region is very great.

Most of the southeast arm of Clear Lake is visible from here, and also a considerable area of the central and western portions of the Upper Lake.

Borax Lake, as seen from here, appears to be inclosed in a perfect little amphitheater of low ridges with steep sides, and indeed, it is so; these ridges, a few hundred feet in height, inclosing its little valley on

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Just before reaching the former locality, we found a little sulphur bank where some work of exploration had been done. The sulphur here occurs in a layer of no great apparent thickness, just beneath the surface of the soil, and is intermixed with the fine material which seems to act as a kind of cement to bind together a mass of obsidianic pebbles. There was no proof of its existence here in any very large quantity.

Some years since there was a considerable rise in the water of Borax Lake, supposed to have been due to the rise in the waters of Clear Lake, which was produced by a dam built by certain parties across the head of Cache Creek, just at the outlet of the lake.

The extraction works of the Borax Company were built at a low level close to the margin of the lake, and the rise of the latter was sufficient at one time to flood some of their furnaces and cause them serious trouble. The extraction works here were extensive, and involved the expenditure of very large sums of money.

Mr. Anthony McCabe informed me that the Borax Company owned about two thousand eight hundred acres of land on this peninsula, between the two arms of Clear Lake, including the Sulphur Banks at the head of the eastern, or shorter arm of the lake, which they rented to other parties, who successfully extracted a large amount of sulphur there.

Before the company ceased operating at Borax Lake, they had, he says, pretty well exhausted the layer of borax crystals which formerly existed in the bed of the lake, and had erected extensive works with a view to extracting the borax from the general mass of the mud of the lake. But these works did not prove a success. Shortly afterwards there was again a rise in the water of the lake which flooded the furnaces, and the work stopped and has not since been resumed.

It is stated that it was found impracticable by simple treatment with water alone to extract from the clayey mud all of the borax which it contained. It was therefore inferred that the mud needed a previous "roasting," and extensive works were erected for this reduction. The mud extracted from the bed of the lake by a dredging machine was first exposed to the action of the atmosphere and the summer sun until thoroughly aerated, and afterwards conducted to the "roasting" arrangement. This arrangement consisted of a rectangular brick chamber in which the dried mud was exposed for a certain length of time to the action of warm, moist air driven through it by a fan-blower, the air being heated and moistened by a small jet of steam turned into the feed pipe from a boiler near at hand. This constituted the roasting.

After being subjected to this treatment for a certain length of time it was removed from the chamber and treated with hot water to dissolve out the borax, the water after a time being drawn off and the residual mud thrown away.

I give the outline of the above so called "roasting" operation as I received it, and cannot, of course, vouch for its accuracy; but judging as well as I could from the buildings and arrangements which were erected for the especial purpose of extracting the borax from the mud, these appear to have been designed and built with especial reference throughout to exactly the sort of silly "roasting" described above. I am strongly inclined, therefore, to believe that statement correct, although I should decidedly prefer to believe otherwise, for, indeed, it seems hardly credible that a company of intelligent individuals should have expended from $75,000 to $100,000 in the erection of buildings and apparatus for a

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most of the larger masses being merely covered with a crust of decomposed material, while their interior is to all appearance unaltered and is hard and compact as ever. But throughout the area of several acres here, over which the solfataric action has once extended, the surface is everywhere whitened by it. This action is not yet entirely extinct. In digging among the rocks to extract the sulphur, the ground was almost invariably found more or less warm beneath the surface, and more or less sulphurous vapor still issues from the crevices, and not infrequently places were opened at which the discharge was so heavy and strong as to drive the workmen out, and sometimes necessitate closing them up again, though generally such places would cool off sufficiently to permit working after being exposed awhile to the air.

The incrustations and stalactites of crystallized sulphur which occur here and there in the cavities among the rocks, are often extremely beautiful, and sometimes the pure and brilliant yellow of the sulphur coating is dotted here and there with little specks of deep and equally brilliant red, proceeding from little aggregations of minute cinnabar crystals. In fact, cinnabar in minute quantities appears to be distributed everywhere throughout the sulphur, and for awhile occasioned special difficulty in its extraction and preparation for the market; but I saw nothing here or elsewhere which bore any resemblance to a "vein of cinnabar traversing sulphur." Moreover, after considerable inquiry at different localities, I failed to either verify or to hear of the existence of such a thing anywhere in this country. I think, therefore, that it must be a mistake, although its occurrence is distinctly stated in Dana's Descriptive Mineralogy.

The sulphur was extracted from the ore by sublimation from cast-iron retorts. The thickness of these retorts was seven eighths of an inch, and one of them is said to have lasted from two to three months only, being gradually completely penetrated by the sulphur which transformed them into sulphide of iron.

More or less cinnabar was deposited as an incrustation in the pipes leading from these retorts, and there was always sufficient mercury in the retorted sulphur to impart to it a dirty greenish color, which would render it entirely unfit for market. It was, therefore, subsequently treated while in a liquid condition, in large cast-iron pots, with certain chemicals in order to destroy this color.

The chemicals employed for this purpose are stated to have been commercial sulphuric acid, chloride of sodium, and nitrate of soda. An order from the works for a quantity of these articles required them in about the following proportions, by weight: Commercial sulphuric acid, seven parts; nitrate of soda, ten parts; chloride of sodium, twenty parts. But exactly how, or in what proportion they were employed in the pots, I did not learn. Their effect was probably not to remove the mercury which contaminates the sulphur, but to change its sulphide into some colorless salt, such as the sulphate or the chloride, which will not influence the color of the sulphur. From these pots the liquid sulphur was run into boxes for the market.

Close by these sulphur works are hot springs, whose waters were analyzed by Mr. Moore (see Geology of California, Vol. I, p. 99), and just south of the works there is a cool soda spring, and near by it is a mass of incrusted and petrified tule roots, etc.

From Lower Lake we traveled to Kelseyville. Dr. Adams, of Lower

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Lake, informed me that a seam of coal some eight or ten inches in thickness has been found at a point about two miles southeast from Lower Lake. It is said to be now, however, entirely covered up with debris, and I did not visit the locality.

He also spoke of marble at a locality some three miles distant a little east of north from here; also, of sulphur springs, both hot and cold, in a branch of Jerusalem Valley, and some four or five miles east of Coyote Valley, and about one and a half miles north of Puta Creek; also, of sulphur near Jamison's, about nine miles from Lower Lake, and a half mile south of the Kelseyville road; also, of white sulphur springs near Campbell's, about two and a half miles southeast of town; also, of cold soda springs four miles east of town.

From Lower Lake to Kelseyville, about sixteen miles, all the rock seen in place was volcanic. The road passes over the broad, low, hilly region southeast of Uncle Sam Mountain. From Lower Lake to the summit of this road the distance is about nine and three quarters miles, and for a distance of three or four miles before reaching the summit the whole country is strewn and covered with obsidian pebbles and bowlders, scarcely any other rock being visible. In fact, for most of the distance no rock was seen in place, but nearly all the pebbles in the gravel are obsidian, while over large areas the surface is perfectly black with a layer of clean and waterworn obsidian pebbles, often free from sand to the depth of several inches. The great mass of these pebbles do not exceed probably a cubic inch in average size, but in many places large bowlders of it are plentiful, and these are frequently hundreds of pounds in weight. Moreover, at several localities large masses of it were seen, apparently in place. Its quantity is simply enormous, and it must cover a broad extent of country.

Mr. Craven made, from Kelseyville, a two days' trip to Cobb's Valley, upon which I did not accompany him. On this trip he followed the old road, joining at the sawmill the newer road from Kelseyville to Calistoga (which, as already stated, goes through Cobb's Valley), passing west of Mount Hannah.

He reports that the obsidian above described as covering so large an extent of country, appeared to stretch in a broad belt southwesterly across his path (it does not, however, extend to any great distance to the west of where he now crossed it, as will be seen hereafter), and that in one place along the mountain side this new road was literally hewn out of a mass of solid obsidian for a distance which he estimated at not less than four to five hundred yards.

Mount Hannah is, to all appearance, entirely volcanic, and from it there runs northwesterly, between Cole and Kelsey Creeks, a long ridge, which is also volcanic, except its southwestern slope low down, which is metamorphic. Nothing but volcanic rock was seen to the north and northeast of the crest of this ridge; but from the point at which the road first touches the metamorphic region on the southwest slope of this ridge, no more volcanic rocks were seen along the road, and everything is metamorphic all the way to Cobb's Valley.

From Mount Hannah there runs southeasterly to the Harbin Mountain a ridge dividing the waters of Seigler and Kelsey Creeks.

A small stream heading south of Mount Hannah and flowing into Kelsey Creek, is called Sulphur Creek, and there are said to be sulphur

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banks along its course, and a variety of mineral springs whose waters meet and mingle in the creek.

On Kelsey Creek, about three miles below Cobb's Valley, are said to be fine copious soda springs.

Mount Hannah, as seen from this direction, seems a perfect cone.

At a point about three hundred yards south 87 degrees east from Kelseyville, and two or three hundred feet south of the Lower Lake road, there is a low gravelly knoll whose pebbles are volcanic and metamorphic, consisting chiefly of jasper and obsidian, and from this knoll there is a constant small discharge of inflammable gases. This fact is said to have been first discovered as follows: A man at one time attempted to dig a well here, and after having commenced his work by digging a hole two or three feet deep in the gravel, he stopped to light his pipe, after which he dropped the still blazing match into the hole in which he stood, and the instantaneous result was a firing of the inflammable gas, which blazed up around him. There still remained on the knoll at the time of my visit a small excavation, a couple of feet in depth, from the bottom of which gas constantly issued, and in which there was generally a small quantity of it collected. On lighting a piece of paper and dropping it into the hole the gas took fire and produced at first a considerable volume of flame, blazing up to the height of four or five feet. This lasted, however, only a few seconds, for the accumulation of the gas had then burned out. There remained a very little flame, flickering unsteadily about the bottom of the hole, sometimes for several minutes before finally going out.

The quantity of gas discharged here is said to vary at different seasons, and to be sometimes large enough to enable it to burn steadily for a considerable length of time; even moderate winds not sufficing to extinguish it.

The flame is non-luminous in the sunlight, and almost perfectly transparent and invisible, its presence then being only evidenced by a sound which it produces, and by the rapid, tremulous, wavy motions of the burning gas. There is also a slight odor of sulphur, either in the gas itself or in the products of its combustion, and the odor of the dense gas which collects in the bottom of the hole is most intensely suffocating. I suspect it to consist chiefly of a mixture of marsh gas, with carbonic oxide, and perhaps some carbonic acid with sulphuretted hydrogen or sulphurous acid.

At other points scattered over the surface of the hill the same gas in smaller quantities may be detected.

From Kelseyville we ascended Uncle Sam. The two main summits of this mountain are something over half a mile apart, in a direction about north 60 degrees east magnetic, and there is very little, if any, difference in height between them. They are connected by a somewhat irregular saddle, whose depression, however, is not great.

The whole mountain is volcanic from base to summit, so far as seen; indeed, no rocks of any kind, except volcanic, were seen in place anywhere southwest of Clear Lake and to the north of the road from Lower Lake to Kelseyville.

The rock which chiefly constitutes the mountain appears trachytic, and bears considerable resemblance to that of the Cobb Mountain. There are no signs whatever, so far as I saw, of any crater at the summit. The rock in places appears rudely columnar in form, but in the

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beaches here are chiefly volcanic, with a large percentage of pumice and scoriaceous rock, but some jaspery and other pebbles of a metamorphic nature are mixed with them.

If some kind of structure high enough to overlook the trees were erected at the western end of the ridge and promontory of Elgin's Point, this would be as fine a point of view of the lake as any that could be obtained in the country. Almost the whole of its surface can be seen from here, and Clear Lake is, indeed, a beautiful sheet of water. Its shores on the south and west from the western foot of Uncle Sam around to Upper Lake are either flat and level, or else low and gently sloping hills; but almost everywhere else around the lake the mountains are high and generally very steep.

Little Borax Lake occupies the lowest portion of the little basin immediately southeast of the saddle which connects Elgin's Point with the main mountain, and close to the shore of Clear Lake. At the time of my visit they were extracting, with apparent success, the borax from the water of this Little Lake. It was stated to me here that the density of this water was about 8 degrees Baumé, that of the water of Borax Lake being between 3 degrees and 4 degrees Baumé. It was further stated that the mixture of salts contained in the latter consisted of from 25 to 30 per cent of borax, the remainder being chiefly carbonate of soda, with, however, about 8 per cent of common salt.

If these statements be correct, it would follow from them: First, that the water of Little Borax Lake contains between two and three times as much solid matter as that of Borax Lake; second, that of this solid matter the percentage of borax, though nearly the same, is, nevertheless, a little higher at the Little Lake; and third, that at the latter locality there is far more carbonate of soda and far less chloride of sodium than at Borax Lake. I find, however, that the sample of water from Borax Lake, which was analyzed by Mr. Moore (see Geology of California, Vol. I, p. 98), must have possessed a specific gravity more nearly approximating this than 3 or 4 degrees Baumé, but what changes may have subsequently taken place in its density, in connection with its changes of level, I do not know.

The water at the Little Lake was first concentrated by solar evaporation in large areas floored or paved with brick, a brick margin being raised around the edges sufficiently high to hold the water to a depth of a few inches, and the whole surface being covered with asphalt to render it water-tight. When the concentration had reached a certain point, the water was drained off from these vats and further concentrated to saturation by boiling.

The hot saturated solution of mixed salts was then placed in tin milk pans and cooled and crystallized. Hundreds of these pans were used. After crystallization, the water from them was drawn away and the salts were washed with cold water, which readily dissolves the carbonate of soda and common salt, but comparatively little of the borax. The washed borax was then redissolved in boiling water, and the hot saturated solution thus obtained run into large wooden vats in which it slowly cooled, and the borax crystallized on the interior of the vats and on numerous strings which were suspended in the solution from sticks laid across the tops of the vats. The carbonate of soda was afterwards purified from the salt which it contained.

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to be made up of similar steep ridges and similar metamorphic rocks. I could not determine whether the rather high, round, double-topped peak which bears south 64¾ degrees east magnetic about four miles from here is metamorphic or volcanic.

There are three peaks which look from here like a triple-topped mountain, and the middle one of which bears north 53½ degrees east about four and one half miles. These peaks are in the ridge between Cole and Kelsey Creeks, and the most northwesterly one appeared to be capped with volcanic rock.

We are now in a position which enables us to trace approximately the western margin of the volcanic country from Mount St. Helena to Clear Lake. Beginning at the western foot of Mount St. Helena, the line going northerly at first rises high up on the western slope of the main watershed, which extends from Mount St. Helena to the Cobb Mountain. Whether this watershed is covered so far as the Cobb Mountain with a continuous belt of volcanic rocks, I do not know, though I suspect that it is not. It is certain, however, that for the whole distance between Mount St. Helena and the Cobb Mountain the western margin of the volcanic region is nowhere far to the southwest of the crest of this divide.

On reaching the south side of the Cobb Mountain, the line turns westerly, curving around the western and northern foot of the mountain, then making a deep bend to the east around the head of Cobb's Valley, passing along the northwest foot of Harbin Mountain, then following along not far from the crest of the ridge, connecting the latter mountain with Mount Hannah, but passing southwest of the latter peak and continuing along the southwest side of the long spur running northwest from Mount Hannah between Cole and Kelsey Creeks, nearly, if not quite to the end of this spur. From thence the line crosses Cole Creek and continues along the eastern line of Big Valley, that is, the western foot of Uncle Sam, to the shore of the lake. Here it abruptly stops. There was nothing volcanic seen in the country northwest of Uncle Sam.

It has already been stated that the entire mass of Uncle Sam is volcanic from base to summit, as well as the whole southwest shore of the longer arm of Clear Lake, while northeast of this arm the country is only partially volcanic; and it may be interesting in this connection also, to continue on beyond Uncle Sam, and trace at once the line which seems to circumscribe the volcanic country on the north and northeast so far around as Beryessa Valley. If, then, beginning at the northeast corner of Elgin's Point, we follow first a straight line to the northeast corner of High Valley, thence a straight line to the sharp bend of the North Fork of Cache Creek at the northwest foot of Chalk Mountain, thence up the North Fork of Cache Creek to the broader bend near the foot of Little Indian Valley, thence a straight line to the mouth of the North Forth, thence down the main Cache Creek to the great gap where it breaks through the great unaltered cretaceous ridge toward the Sacramento Valley, and thence southeasterly along the crest of this ridge as far as Beryessa Valley, we shall include everything volcanic which was seen by any of us during our trip, and in all probability, so far as our observations enabled us to judge, everything volcanic which actually exists in this country. And, indeed, it is probable that along the northeastern margin this line may be drawn considerably closer than I have done it above. As will be seen hereafter, it is probable that from the bend of the North Fork of Cache Creek east of Chalk Mountain and south of

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and jaspers of the Coast Range farther south. There is more mica, too, in the sandstones, and the shales often show more tendency to approach hard slates than jaspers. After reaching the foot of the mountains we returned on the same evening to Upper Lake.

Another spur was climbed just south of Clover Creek. The exposures here are very poor, and the south side of the spur is completely covered with chamisal. But so far as the country can be seen it appears to be all metamorphic. The soil is thin and filled with broken fragments of sandstones, often micaceous, and shaly bits of quartz, serpentinoid rock, shales, jasper, etc., and is in places very ferruginous.

Scott's Valley and Bachelor's Valley have rich soil and contain some good farms, and I saw in them some fields of the best Indian corn which I have ever seen in the State.

Between the upper portion of Bachelor's Valley and Scott's Creek, or "Tule Lake," a belt of low, rolling hills of metamorphic rocks extends almost entirely across the valley.

Around the little town of Upper Lake, there are some two or three square miles of good land.

Upper Lake itself is surrounded on all sides, except on the south, by an irregular patch of tule swamp, which covers, perhaps, one or two square miles.

The valley of Clover Creek for two or three miles, like that of Middle Creek, is very narrow, and contains a little good land; though both these valleys are probably more or less subject to overflow in freshets.

On leaving Upper Lake we traveled southeasterly along the northeast shore of Clear Lake nine and one half miles to Morrison's, where we made camp again.

No rock was seen in place to-day until within two or three miles of Morrison's, beyond which point metamorphic sandstones with reticulations of quartz cropped out at various points along the shore. At one point these rocks were observed to strike northwesterly and dip northeasterly. The hillsides to the north look smooth and very ferruginous. There is at Morrison's a fine cove and some good level land inclosed between the foot of the mountains and the lake shore.

From Morrison's we traveled southeast along the lake shore, and climbed to a point of observation at the summit of the Red Mountain, nearly opposite and a little west of north from Elgin's Point. All the rocks seen on this trip are more or less metamorphosed. At a point about one and a half miles from Morrison's, on the lake shore, are sandstones more or less micaceous, and shale, with some thin shells, the whole but very partially metamorphosed, striking north 25 degrees west, and dipping 15 to 20 degrees northeast.

The whole northwestern spur of the mountain up which we traveled is made up of metamorphic shales, which often show a tendency to weather in irregular splinters, rather than in plates. Their strike is nearly parallel with the axis of the spur, *i. e.*, about north 60 degrees to 65 degrees west magnetic, and their dip 50 to 60 degrees southwest. But near the summit some of them stand nearly vertical, and in places the dip is reversed, being at a high angle to the northeast.

This peak is separated from the main ridge back of it by a gap forming a saddle, from which a deep cañon runs in either direction, one going northwesterly towards Morrison's Cove, while the other goes southeasterly to Atter's Cove. The summit itself is made up of slates somewhat

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similar to those of the spur up which we climbed, but rather heavier-bedded, somewhat contorted and broken, and not exhibiting well their strike and dip.

About the summit, also, there is much impure quartz which contains considerable quantities of exceedingly minute drusy crystals. The slates themselves are argillaceous, ferruginous, and siliceous.

In Atter's Cove, a mile or so to the southeast of this peak, there are, perhaps, a dozen acres of level and apparently good land upon the shore of the lake. Beyond this, to the eastward, rises the ridge between Clear Lake and High Valley, which appears to be metamorphic throughout. Portions of its slopes look very red and ferruginous. It is partly covered with chamisal and partly with open oak timber, mingled along the crest with pines. There was nothing volcanic on this side of the lake noticed from here. The contrast between the steep, volcanic, bluffy slopes of Uncle Sam, so close at hand, and this mass of equally steep, but entirely metamorphic sedimentary mountains, is striking and curious in its effect.

The next day we traveled northeasterly three and one half miles up the mountain, and made camp at the sawmill on the crest of the Lake Ridge among the clouds, which had been all day gathering. The next morning the ground was white with snow, which was still falling; but we proceeded down the northeastern slope and camped at Harrison's place, in the head of Long Valley.

The exposures of the rocks on either slope of the Lake Ridge along this road are rare and poor, but everything seen was metamorphic.

On the following day we started back towards the sawmill, and climbed to the edge of the clouds, which hung far below the mountain tops, hoping that they might lift and give us a chance for observations somewhere on the crest, but the clouds did not lift and we were obliged to return.

The rocks in this region, so far as seen, are metamorphic sandstones and slates, but little jasper and scarcely any serpentine being seen. The strike and dip are rarely exposed, but the former is probably northwesterly. Much of the soil is ferruginous. In the spur close by camp at Harrison's, there are shaly sandstones slightly metamorphosed, which strike about north 60 degrees west, and dip 60 degrees southwest.

The next day was stormy, but the day after was clear, and we again climbed the mountains to a point of observation on a rocky pinnacle in the crest of the Lake Ridge, and not far from the sawmill.

The rock of this point is a highly metamorphic slate. It shows much decomposed iron pyrites distributed through it in small cubic crystals. It is also full of seams and cracks, which are generally more or less coated with quartz. Some of its small cavities contain a green mineral in very minute crystals, and some of it is very talcose and contains bunches of short actinolite crystals, and much of it is very hard. It strikes here north 60 degrees west magnetic, and stands vertical. The same rock can be followed with the eye for a mile or so to the northwest from here, while it is, I judge, about half a mile wide from here towards the northeast.

It is evident that the degree of metamorphism in this ridge varies greatly. The slates are very highly metamorphosed, but in many places the shales and sandstones are but slightly altered, and, indeed, by far the greater portion seem to have been but partially metamorphosed, though nearly all appear to have been more or less altered.

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Exposures of the softer rocks are almost everywhere, however rare and poor. All the country to the north and northeast from here looks metamorphic in its outlines. A little bit of a valley, called Chiquito Valley, bears north 22 degrees east, about three miles from here. A little stream from the basin of Chiquito Valley runs past Bartlett's Springs and joins the North Fork of Cache Creek.

At a point just south of the crest of a low ridge, and bearing north 25 degrees east, about four miles from here, there is a yellowish white formation, which looks as if mineral springs had been at work there extensively, and suggests a possibility of sulphur. This point is something like a mile northwest from Bartlett's Springs, which are at the southern foot of the same low ridge which runs continuously for several miles between the North Fork of Cache Creek and the little stream which drains Chiquito Valley.

Mount Hannah, which bears south 20½ degrees east from here, is heavily timbered on top, and has heretofore appeared like a sharp cone, but presents from this point the appearance of a ridge rather sharply rounded at the top, and that is probably its real form.

On returning to camp this evening, I obtained from an Indian some small bits of a peculiar variety of rock that is highly esteemed among the Indians here for making large beads. They first burn or calcine the rock, and this is said to soften it so that it can be easily cut. They then work it out by hand, with much labor, into large cylindrical beads, ranging from three quarters of an inch to an inch in diameter, and from half an inch to five or six inches in length, a small longitudinal hole being pierced through the center for the purpose of stringing the bead. The specimens which I obtained had all been calcined, I was told, and I do not think their hardness exceeded five; but it was stated that samples of the uncalcined rock would scratch glass easily. The locality is not certainly known to any whites, and is known to only a few among the Indians, who make a secret of it, as it is valuable to them. I was informed that one of these beads, an inch in length and three quarters of an inch in diameter, would sell among them for from $2 50 to $5, or even more in certain localities among the northern Indians. I could not be certain what the material of this rock is, from any tests which I could then make, but I strongly suspect that it is simply an indurated clay rock, which may, perhaps, owe its hardness to additions of silica from mineral waters. At all events it looks very much like such a rock.

The next day I crossed a saddle at the head of Long Valley and visited Bartlett's Springs, following the trail via Chiquito Valley.

Bartlett's Springs are on the north side of a little creek about one third of a mile below the foot of Chiquito Valley, and at the southern foot of the low ridge which runs between this creek and the North Fork of Cache Creek. This ridge runs about north 73 degrees west magnetic, and curves to the southwest around the foot of Chiquito Valley, connecting with the main ridge to the south.

There are two springs here, both of them cold and both of the class called "soda springs."

The spring, which is most esteemed, is perfectly clear and colorless, and produces no sediment or deposit anywhere near the spring and shows no gas. Its water tastes, however, rather strongly of carbonic acid, though it does not contain enough of this gas to make it separate quickly from

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various Indian dialects, informs me that the name of the mountain spelled "Yallo Balley" on Holt's map, is pronounced by the Indians as if spelled Yawlley Bolly, the "aw" in the first word having exactly the sound in the English word "awe," only cut extremely short,. while the "o" in the second word has the sound of "o" heard in the French word "bonne." He also says that in the name of the mountain spelled "Bullet Chup" on the same map, the first word is really the same "Bolly" as that in the preceding name, while the "u" in the second word should sound like the English "oo," the "ch" having the same sound as in "which." A better way of spelling this name would, therefore, seem to be "Bolly Choop." He also gave me the meaning of several of these names. "Yawlley" means snow; "Bolly," peak; "Choop," needle; "Yawlley Bolly," snow peak; "Bolly Choop," needle peak; "Pass Kenta," under the bluff; "Kicky Wauket," frozen gulch. Pass Kenta is spelled Pas Kinta on Holt's map.

Bartlett's Ridge is, for a considerable distance, the divide between the North Fork of Cache Creek and the headwaters of Stony Creek. The divide between the former stream and the South Eel River runs across northeasterly from the Lake Ridge to Bartlett's Ridge from a point between our points of observation of October thirty-first and November second. Then the divide between Eel River and Stony Creek is a northwesterly prolongation of Bartlett's Ridge towards the Snow Mountain. The Lake Ridge diminishes rapidly in height as it forks out in going southeast from our point of observation near the sawmill.

On the following day we traveled two or three miles down Long Valley, then climbed to the crest of the ridge between High Valley and Long Valley. Leaving Mr. Craven here, I then continued on, descended into the pass through High Valley, crossed the ridge between it and Clear Lake, and visited the volcanic cones at the head of the little valley northeast of the Sulphur Banks. On the next day I visited a crater-cone to the east of High Valley.

The ridge between High Valley and Long Valley continues on unbroken towards the east to the end of Long Valley Cañon. The ridge between High Valley and Clear Lake also continues easterly, unbroken by anything except the little cañon which drains High Valley, to within a couple of miles or less of the North Fork of Cache Creek. Between these two ridges, also, a rather broad depression extends entirely through from High Valley to the North Fork of Cache Creek, and in the center of this depression rises the crater-cone above referred to.

The ridge between High Valley and Long Valley is entirely metamorphic, its northeastern foot being generally sandstones with some shales. The crest, where we saw it on the twelfth, consists of slightly altered shales, which appear to have a strike ranging from northwest to west, with very various dips. The exposures, however, are very poor.

Long Valley is narrow, ranging from one quarter to one half or three quarters of a mile in width. Its soil is generally good; there is no lack of water. The mountains on either side are steep.

High Valley is small, being only about three miles in length. At one point on the southern slope of the ridge north of High Valley, I found a little sulphuretted hydrogen spring.

High Valley drains to Clear Lake through a little cañon at its southeast corner. The ridge between High Valley and Clear Lake appears

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into Long Valley. The exposures in this ridge are everywhere very poor, but along this trail, judging from the fragments scattered over the soil, everything appears to be metamorphic, though some of the rock seems but little altered. Much of the soil is very ferruginous, and both on the northern slope, as well as along this portion of the crest, scoriaceous fragments are mingled with the metamorphic ones in the soil.

While I visited the crater east of High Valley, Mr. Craven took occasion to revisit our point of observation at the crest of the Lake Ridge, near the sawmill, and on his return, instead of following the road along the crest of a long, sharp spur, he kept to the bed of the cañon straight down to the head of Long Valley. He observed that in this cañon the rocks are partially altered sandstones and argillaceous shales, generally striking northwesterly, and dipping for the most part southwesterly, at angles which he estimated to range from 40 to 50 degrees. There are large quantities of shale and good exposures along the cañon, but no fossils were found.

From the camp in Long Valley we made a pack trip through the country to the east, between here and Bear Valley.

The high ridge northeast of Long Valley appears to be entirely metamorphic, though some of the rocks here, also, do not seem to be very highly altered.

The exposures are not generally very good. At a point about half a mile from the mouth of Long Valley Cañon the metamorphic shales and sandstones at the foot of this ridge were observed striking north 50 degrees west magnetic, and dipping about 50 degrees to the northeast; but higher up in this portion of the ridge the rocks dip northeasterly, though in general not so steeply.

We crossed Wolf Creek close to its mouth, and just touching the sharp bend of the North Fork of Cache Creek at the northwestern foot of Chalk Mountain left it again, and, climbing the mountain on the right bank of the creek, made camp high up on the broad mountain spur between Wolf Creek and Little Indian Valley. Before climbing the mountain, however, I traveled half or three quarters of a mile up the cañon of the North Fork.

At the point where we crossed Wolf Creek this stream has cut its way twenty-five or thirty feet deep into the gravel which forms the irregular little basin here where the cañons meet, just west of Chalk Mountain.

On the right bank of the North Fork of Cache Creek, opposite Chalk Mountain, the slopes facing the creek for some two or three hundred feet in height consist of a remarkable gravel deposit, bedded, and about half cemented into a conglomerate, and worn into sharp, deeply cut masses of columnar bluffs by the action of water and weather. At one point the bedding strikes about north 35 degrees east magnetic, and dips 20 to 25 degrees northwest; but at other points it is different and irregular. The dip, however, is nowhere much higher than this, while oftener than otherwise it is much more nearly horizontal. The upper portion of the mass at this locality is yellowish brown in color, and the lower portion bluish gray. The pebbles and bowlders (the latter rarely large) are all well waterworn, and appear to consist of every variety of hard metamorphic rock that occurs in the country northwest of here. On following up the cañon of the creek I found that this material overlies unconformably a mass of jaspery shales, which, wherever seen, were

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the Coast Range are generally covered with open timber, and have far less chamisal.

To the south of the lava outflow from High Valley, which extends out to the North Fork of Cache Creek, other lava bluffs are seen from here to stretch along for a considerable distance facing the northeast, their upper surface forming tables, which seem to slope gently to the southwest.

The crest and a portion of the southern slope of the Chalk Mountain are very white, and although rather low, it is a conspicuous landmark even as seen from the distant summit of Mount St. Helena.

The cañon of the North Fork of Cache Creek is very deep until it debouches into Little Indian Valley from the west, at a point perhaps a mile south of the head of the valley. Then after running southerly through this little valley for some five miles to its foot, it makes a sharp bend to the west, and runs for some three miles through a deep and very narrow cañon to Chalk Mountain, and bending very sharply around its northwestern base, continues then in a nearly straight southeasterly course along a broad cañon with comparatively gentle slopes to its mouth.

We next descended into Little Indian Valley, and crossed the next ridge into Bear Valley.

From our camp by the trail to the edge of Indian Valley, at a point close to its southern end, was about two miles. Within this distance I noticed first large quantities of metamorphic sandstone, but about half way down the mountain we saw considerable serpentine, and then much red and some yellow jasper.

We traveled about nine miles northerly through Little Indian Valley nearly to its head. The soil of this valley is generally gravel, and it is largely subject to overflow in winter freshets. Portions of the valley, however, have some very good soil in irregular patches. Directly opposite the point at which the North Fork of Cache Creek enters the valley, there is said to be a "soda spring" whose water acts as yeast in making bread.

From near the head of Little Indian Valley, two trails go easterly across the ridge to the head of Bear Valley.

There was at one time, it is said, quite a little excitement in this region relative to copper mines. The belt of these copper mines began just north of the more southerly of the two trails above referred to, and stretched northerly for a distance, as I was told, of some eight or ten miles. Large pieces of native copper are reported as having been found in this region, besides rich oxidized ores. The Lyon Claim, situated in the northern extremity of this belt, is said to have furnished some rich ore. I was informed further, that an attempt was once made by *Isenbeck*, of "Black Rock" fame, to smelt these ores at the mine, but that it only resulted in the useless expenditure of some thousands of dollars by the owners. It was further stated that the reason which he assigned for the failure was that "charcoal wouldn't do to smelt these ores with; but that stone coal was needed."

We took the southern trail across the ridge, but saw nothing of any copper ores. The distance between the two valleys on this trail is about four and a half miles. The whole of this ridge is metamorphic, and the stratification generally almost obliterated. The more or less elongated forms of the outcrops of the harder rocks, however, where such

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range of highest mountains which extends from Uncle Sam southeasterly through Mount St. Helena, appeared to consist almost exclusively of solid, heavy lava in irregular, scattered, and isolated patches. This lava is indeed generally somewhat vesicular, but not highly so. But relative to the supposed northeast line of cross fracture extending from the Geysers to the Colusa Springs, the occurrence of hot springs is mentioned as an evidence. Now, the line in question, if straight, would just touch the southeastern extremity of Clear Lake, and pass very close to Seigler's Creek; and though it is by no means improbable, that between the headwaters of Seigler's and Colusa Springs there may be, not far from this line, more or less hot springs, yet within this distance, which comprises about two thirds of the distance from the Colusa Springs to the Geysers, hot springs are not so plentiful that we saw or heard of them along the line of our travel. Harbin's Springs are said to be hot, and I was informed of hot springs somewhere east of Coyote Valley. But these springs, as well as the solfataric action at the Sulphur Banks and Chalk Mountain, are at some distance from any very direct line connecting the Geysers with the Colusa Springs, and altogether outside of the limits of any very narrow belt which might be supposed to depend for its explanation upon a continuous fracture.

Relative to soda and other mineral springs which are not hot sulphur, these are scattered far and wide throughout the country, and far beyond the limits of the volcanic region. Relative, further, to the limits of the volcanic region itself, I may here mention that at one point southeast of Knoxville we climbed to the crest of the great cretaceous ridge which is broken through by Cache and Puta Creeks, and that from this point, overlooking the hills to the east and the Sacramento Valley, I could see no indication of anything volcanic to the east of the crest of this ridge, nor along the crest itself. I am strongly inclined to think, therefore, that the volcanic region does not extend east of the western foot of this ridge, and that it is, in reality, circumscribed by a line which I have already drawn, at least as far to the south as Beryessa Valley. I think, moreover, that the volcanic rocks which are so widely scattered over this lower country to the northeast of the main range of high volcanic mountains, consisting of Uncle Sam, Mount Hannah, Harbin Mountain, Cobb Mountain, and Mount St. Helena, are, in all probability, of more recent date than the rock which forms these mountains, and this impression agrees with the opinion expressed in the report. Admitting it, then, to be correct, if this field of more recent volcanic action is, in reality, circumscribed by the lines which I have drawn, it will be seen at once, on referring to the map, that its diameter in a northwesterly and southeasterly direction is considerably greater than in a northeasterly and southwesterly direction at any point. It seems to me that if any very extensive lines of fracture had been produced by volcanic agencies themselves, we might look for them with more probability in a direction more nearly parallel to the greatest extension of the volcanic belt itself than in a direction at right angles to it. But the fact is that throughout this region I have failed to see any distinct evidence of any extensive lines of fracture anywhere attributable to volcanic action. It seems to me that the facts which I have gathered (which are, indeed, scanty enough at best) do point to the conclusion that the lines of fracture, or rather the fissures, were numerous but short, probably running in various directions, and scattered far and wide over the country. Indeed, the whole

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east, and a dip, which is sometimes very gentle, to the southeast, but varies greatly.

The quantity of these unaltered shales and sandstones appears to be greater southeast of the cañon than it is on the northwest of it. The stratification of metamorphic rocks is generally obliterated.

For some distance above the soda spring there is also in spots considerable calcareous tufa which has been deposited by scattered springs, now extinct. I did not see anything of the seam of coal, some five or six inches in thickness, which is said to exist somewhere in Grizzly Cañon.

Nothing volcanic was seen in this region on the North Fork of Cache Creek.

Immediately below this soda spring in Grizzly Cañon, I struck the eastern edge of a very extensive gravel formation, similar to that already noticed to the northwest of Chalk Mountain.

This formation appears here to form a broad belt stretching northwesterly from Grizzly Cañon along the northeastern side of the North Fork of Cache Creek, and extending without interruption almost to the foot of Chalk Mountain. On the southwestern side of the North Fork, it probably also covers a broad area, which, however, I had little chance to investigate. It also extends southeasterly along the North Fork as far as I could see below the mouth of Grizzly Cañon, and I was informed that it extends quite down to the main Cache Creek, and then for some distance farther east along its left bank.

This formation varies in the character of its material from coarse, bowldery gravel to fine sand, and, if I am correctly informed, it also contains some pretty extensive clay beds.

It appears generally to be about half consolidated into rock. It is everywhere stratified, and the beds are wavy and strike and dip in various directions, though the dip appears nowhere to be very high, and is often very nearly horizontal.

At one point, however, about a third of a mile below the "soda spring," I noticed a strike about north 45 degrees west, and a dip of 20 degrees to the southwest.

Throughout the lower portion of Grizzly Cañon these half consolidated beds are chiefly gravel, with some sand, and they are exposed in cliffs, some of which are probably four hundred feet or more in height, and frequently weather and break in sharply pinnacled forms. None of the gravel, so far as I saw, contains any very large bowlders. Its pebbles consist of almost every variety of metamorphic rock in the country, but also, to some extent, of unaltered sandstones and shales, all waterworn. In this vicinity the material generally has a reddish, sandy color.

Along the North Fork of Cache Creek, however, above the mouth of Grizzly Cañon, the color of the beds is generally a bluish gray, and some of them are said to be adhesive clay. Here, too, they seem generally to have a more northerly strike and rather a higher westerly dip. I found no fossils in this deposit, but took it to be Tertiary or Post Tertiary in its origin. A lava-flow, or perhaps a succession of flows, from High Valley extends out quite to the right bank of the North Fork of Cache Creek, which, however, it does not seem to cross. Its eastern front along this creek is probably one and one half or two miles long, and is often bluffy, extending northwesterly to within a few hundred

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the right bank of the creek as already noticed, and the second one overlying it and terminating in an irregular line of low bluffs a short distance west of the road, and in places perhaps a mile from the creek. Just below Captain Roe's house there comes into Long Valley Creek from the southwest a stream which I estimated at not less than fifty miner's inches of pure fresh water, which issues in numerous copious springs from beneath the lower margin of the upper lava-flow.

Much of the surface of the lower flow is covered with soil which might be easily irrigated to some extent by this water, and which would probably be fine for the vine.

Immediately southeast and south of this lava-flow a cañon makes up toward the west, between it and the higher volcanic bluffs to the south, which appear to be entirely disconnected with it; and along the road which follows up this cañon the lower hills which underlie the lava-flows are seen to be made up of the same stratified gravel, sand, etc., which form the hills around the lower part of Grizzly Cañon.

At the lowest exposure, and the only good one I saw of the bedding, these beds have a very gentle northerly dip.

The little stream running along this cañon apparently contains considerable lime, and has cemented to a hard conglomerate the loose gravel of its bed. From the crest of the divide at the head of the southern branch of this ridge the road descends into the east end of Weldon's Valley, already described. The crest of this divide just where the road crosses it is metamorphic sandstone, and the higher hills to the west of it and north of Weldon's Valley appear to be also metamorphic; but towards the southeast the crest runs immediately into the broad volcanic table or series of tables, at the northeastern edge of which are the lava bluffs already noticed facing the northeast and stretching southeast with more or less interruption to nearly opposite the mouth of Grizzly Cañon.

On the northeast of these bluffs throughout the strip of lower hills two or three miles in width which intervenes between them and the North Fork of Cache Creek, and also in the higher hills with a tolerably sharp culminating peak, which fill the region between the southeastern portion of these bluffs and the North Fork and the main Cache Creek, I saw nothing that looks volcanic from any point that I reached. It is probable that this region consists to a great extent, if not entirely, of the stratified gravel formation.

After crossing the eastern end of Weldon's Valley the road runs around the eastern end of the ridge between Borax Lake and the Sulphur Banks, and then descends by a long and gentle slope into the head of Burns' Valley.

The volcanic table just noticed east of Weldon's Valley is the same one which was seen from the summit of the crater northeast of the Sulphur Banks, and its surface has a general and gentle slope to the northwest.

All along the road around the ridge between Weldon's Valley and the head of Burns' Valley there are no heavy projecting masses of volcanic rock, but all over the gentle slope volcanic bowlders are strewn so thickly that the whole surface may be said to be volcanic. The rock is probably in place close to the surface, though it does not project, and the surface is probably that of a lava-flow.

Lower down toward the head of Burns' Valley there is a heavy deposit

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erous stratum is full of the shells, but is not well exposed and seems to be only about three or four feet in thickness.

In the afternoon, hunting about for another locality of which Dr. Adams had told me, I followed up the gulch back of Scranton's place on the north side of Cache Creek and just southeast of the large volcanic table, and traveled about considerably among the hills between the southeast margin of this table and the creek. All the hills in this region, so far as I saw, are unaltered sandstones, shales, and pebbly conglomerates. These rocks are much broken up, and in different places strike and dip towards every point of the compass, although the most frequent direction appears to be a northwesterly strike and southwesterly dip.

I found, at last, the locality of fossils, but found only one species of shells at this locality. It is in the bed of a rocky gulch about a quarter of a mile north 35 degrees east from Scranton's house. The fossils occur in argillaceous limestone in the bed of a watercourse. There is no other rock visible in the vicinity, the soil appearing to be deep and the quantity of fossil-bearing rock itself which is visible is very small, its exposure being too poor to show its strike and dip; indeed, it may be only some heavy bowlders, though I am inclined to think it is in place.

What the exact age of any of the volcanic rocks which we have seen in the course of this trip is, I do not know. But, as I have already stated, I am inclined to believe that the more coarsely crystalline rocks which make up the great mass of all the highest volcanic mountains, as Uncle Sam, Cobb Mountain, and Mount St. Helena, and which appear, so far as I could judge from what I saw, to have been ejected in massive form, are older than the lavas which cover so much of the country northeast of that range of peaks, while the lava-flows from the vicinity of High Valley, together with the tables south of them and west of the North Fork of Cache Creek, are evidently more recent in their origin than the gravel formation which covers so extensive an area about Grizzly Cañon and the North Fork of Cache Creek.

Dr. W. O. Ayres, who owned the Little Borax Lake, and who was also interested in the property of the California Borax Company, told me that Borax Lake was actually higher by several feet than the water in Clear Lake ever was, even at the time of its highest stage before the dam at the head of Cache Creek had been removed. If this be correct, it is of course impossible that the rise of the water in Borax Lake (of which rise, as a fact, there can be no doubt) should have been caused by the rise in the waters of Clear Lake, as has been supposed.

Naturally, Dr. Ayres supposes that the rise in Borax Lake was caused by the quantity of water which was discharged from some of the borings made in the bottom of the lake or in the adjacent flat. He states that one of these borings, with a pipe five or six inches in diameter, discharged a constant stream with force enough to keep the top of the jet at a steady height of several inches above the mouth of the pipe. Now, it strikes me that one such jet as this would be sufficient to account for a considerable rise in so small a lake as Borax Lake, and it strikes me further that it would have been an easy matter to have turned this stream, whose water is said to have contained very little borax, in some other direction instead of allowing it to flow into the lake, or else have stopped it up and prevented its flow entirely; but none of these things were done.

Dr. Ayres also corroborated the description I have given of the "steam-

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There are great quantities of serpentine in the country about the quicksilver mines, and also at one or two other localities between Middleton and Kelseyville. But the greater portion of the rocks along this road are volcanic.

At the gas locality near Kelseyville, there is now a pulsating artesian well which throws a jet of water fifteen to twenty feet high along with considerable gas.

From Lakeport I crossed the mountains by the stage road to Hopland, and thence to Ukiah. The summit, where the road crosses it, is about two thousand three hundred and fifty feet above the sea. Along this route nothing of volcanic origin was seen; but the rocks everywhere consist of more or less metamorphosed sandstones and clay rocks. The stratification is mostly obliterated, and the sandstones are generally blocky, *i. e.*, shattered and broken into irregular angular fragments.

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mence to ascend, after leaving Moran, we pass through a granitic country, with occasional dikes of diorite. From Liegan the road turns to the northwest around the south end of Honey Lake, over a flat alkaline plain, until it reaches the east flank of the Sierra Nevada Divide, along and between which and the lake the road skirts until it reaches Susanville, at the head of Honey Lake Valley, a distance of forty-two miles from Liegan. The town, which has an altitude of four thousand two hundred feet, is situated on a side hill at the foot of a bluff of volcanic tufa, which is being utilized for building purposes. When first quarried, it is soft enough to hew into shape with an ax; after exposure it hardens, but never attains sufficient hardness to be accounted a first-class building stone. Lassen Butte, which is partly in this county, with the smaller craters in its surrounding neighborhood, seems to have been the source whence the lava-flows which reach into this neighborhood have emanated. Six miles to the southwest of the town, on the eastern flank of the Diamond Mountain Divide, spasmodic attempts have been made for a number of years to develop some quartz veins that were found in the granite of this main backbone. After having lain dormant for a time, they are, during the present season, being handled by parties who seem to be determined to prove their actual value. The most prominent of these prospects are the Lone Pine and Union ledges, the Golden Gate Mine, and its northern extension, the Afterthought, Gray Eagle, and Golden Belt claims. The first mentioned is opened by tunnels and shaft, and the stringers of quartz course north and south, dipping about 60 degrees west. On the surface, they had only a two-inch vein, but in the winze sunk to a depth of forty feet the quartz is from two to three feet wide in the bottom, and gives in the hornspoon an apparent value of $40 per ton. Two other stringers, at a relative distance of about fifty feet from each other, with a somewhat straighter dip (about 80 degrees), do not seem to contain much gold. Around the last of these stringers the granite walls assume more the nature of "greisen." The mill belonging to this property, but which is not running at present, contains ten stamps of five hundred pounds weight, with single cams, having a somewhat different curve from the usual double cam, and working on a tappet with a concave face, for the purpose of imparting a rotary motion to the stamp while on the die. The mortar, forty-one inches by eight inches, has all the sides made of wood, lined with boiler iron, and bolted to the cast-iron trough bottom. The aprons are four feet by five feet ten inches, with twelve feet of sluice, twenty inches wide, covered with silvered plates. They use a No. 9 diagonal slot screen in a frame three feet four inches by ten inches.

NORTHERN EXTENSION OF GOLDEN GATE

Is situated in Sec. 24, T. 29 N., R. 11 E., at an altitude above sea level of four thousand seven hundred and fifty feet, about seven miles from Susanville. It was located in 1888, has a shaft started, now down eight feet, and a tunnel one hundred and fifty feet long run in on the ledge, which courses 60 degrees east of north; it is almost perpendicular. The vein is about six feet wide, and shows good walls and a clay gouge. At present two men are working here. The current wages are $30 per month, with board. Timber is plentiful, costing about 3 cents per running foot, and 3 cents a piece for lagging.

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Turning to the north from Susanville and following the stage road, after crossing some rough lava debris the road ascends over a divide, capped, as all the ridges through this section, with basaltic lava. This is known as Antelope Hill; it divides Honey Lake from Willow Creek Valley; this latter is to a large extent swamp land. Through the valley a stream of like name courses, which is supposed to derive its waters from Eagle Lake, immediately below which the large springs break out of the lava rock that are its visible head. At this point near which the stage road passes, a tunnel has been started to run under and tap Eagle Lake for the purpose of obtaining a supply of water with which to irrigate the sagebrush lands east of Honey Lake; the work is suspended at present, but the tunnel is well under way. The hills surrounding Willow Creek Valley show a marked difference; those to the west are thickly wooded and in them mineral veins have been found, but so highly charged with sulphurets that at the time of their discovery they could not be profitably worked, and nobody, of late years, has cared to relocate them. The hills to the east are bare, excepting for sagebrush, the soil more or less impregnated with alkali. Following the course of Willow Creek to its head, the road emerges onto the border of Eagle Lake, which it skirts close to the water's edge for a distance of over five miles. It is here that the resemblance to the rim of a crater is so marked; the basalt forms the material and is checked up through contraction in cooling. The effect of frost and other meteorological influences in the formation of our earth's surface can be seen here to great advantage, inasmuch as between the bluffs of eruptive rock forming the boundary to the lake area and the water, a large amount of bowlders that have been severed from the original by natural forces are piled upon one another forming a large talus. The road on emerging from the lake crosses a ridge of volcanic debris and basaltic rocks for a couple of miles, and then skirts another valley which has formerly been the bed of a lake, and still contains some water in its most depressed part. This was formerly known as Grasshopper, now called Meadow Valley; the northern portion of this ground, which used to be known as Sed Valley, has been converted into a reservoir. From Eagle Lake a branch of the Sierra Nevada Mountains turns to the east toward the Madeline Plains, and thence turning to the north forms the Warner Range in Modoc County. Surrounding Grasshopper Valley on the east are numerous smaller valleys, either connected by narrow depressions or divided by low-lying ridges, all of which have undoubtedly, at some former time, been lakes or parts of one large body of water; the underlying strata are nowhere visible through here on account of the capping lava-flows. After leaving here the road ascends pretty rapidly, going nearly due north over a wooded ridge of the Sierra, until, at an altitude of six thousand four hundred feet, we reach the largest mining camp in the county, Hayden Hill. The south and east part of the hill shows exposures of quartzites and metamorphic sandstones overlaid with rhyolites, tufas, and volcanic conglomerates, while to the northwest of the hill for a short distance cretaceous formations appear quite prominent. The hill proper affords an interesting study to the geological student, showing, as it does, so many changes and varieties of volcanic rock within a comparatively small area.

Since the issuing of the last report, the Golden Eagle Mine, in Hayden Hill Mining District, has found the vein on the west end of their works,

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LOS ANGELES COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

SANTA CATALINA ISLAND.

Opposite to San Pedro, eighteen miles beyond the main land, but belonging under the jurisdiction of Los Angeles County, is the island of Santa Catalina, the farthest inland of the islands lying along the southern coast of California. In general physical characteristics, it presents a rugged mountain chain, running lengthwise through the island, with spurs extending down to the coast, separated by deep cañons with precipitous sides, and finding their outlet on the seacoast. In some few cases, more especially on the side of the island next to the main land, these outlets form coves, or harbors, where boats of light draft may ride at anchor and land their cargoes. These are, generally speaking, fishing schooners. At the principal harbor, where the only village of the island is situated, Avalon, during the summer season a steamer makes regular trips from and to San Pedro.

There is little or no agricultural land; indeed, it would be a hard matter to find one hundred and sixty acres of tillable land in any spot on the island. In some of the coves, fishermen have built their homes and have spaded up little gardens, notably at Avalon; but as a general rule, the small population on the island look to the mainland for their supplies. Few trees grow here. With the exception of some stunted oaks, a few elders, and cottonwood, there is nothing but some so-called ironwood trees and some bushes to be found. The natural growth of the hills is grass, and the island is leased to a Mr. Frank Whitley for grazing purposes, he having it stocked with five or six thousand head of sheep. From former times there are several hundred head of goats running wild, but these are being exterminated as rapidly as possible. There are no roads on the island, communication between different points being carried on by means of boats, or on horseback over trails that keep to the main ridges. In this way there is one main trail running through the island from south to north, with side branches to the different coves. The highest point on the island, Black Jack Peak, is in the neighborhood of two thousand feet high, while the average altitude of the main backbone is from one thousand four hundred feet to one thousand six hundred feet.

The island is about twenty-five miles in its greatest length and about seven miles in its greatest breadth, with an area of between forty-seven and forty-eight thousand acres.

Upon approaching the island from the mainland, and also in passing through it, it conveys the idea of a shattered mass; as if some great dynamic forces had been exerted under its foundations, and yet not of a sufficient strength to entirely remove the superincumbent mass. Old residents tell of frequent occurring slides of rocks and earth in the interior cañons, as well as along the coast, without any apparent cause, and to the west, and finally empties itself into the ocean, traces of mining are met with; a tunnel thirty feet long has been drifted into the side-hill, but for what purpose does not appear.

Not far from the junction of the two cañons another tunnel has been drifted on a small vein containing calcite, galena, and zincblende, the latter predominating. This vein courses 47 degrees east of north, and dips 70 degrees to the west. It is about one foot wide; the tunnel follows the vein for a distance of seventy-five feet.

Shortly after entering Grand Cañon, a quartzite dike, coursing 25 degrees east of north, crosses the cañon. Near the termination of Silver Cañon the sides are not more than one hundred feet apart, very abrupt, and consist in part of a fine-grained granite. A larger part of the cañon is cut through eruptive and metamorphic rocks. On the whole length of this cañon there is a grade of one thousand two hundred feet—nearly three hundred feet to the mile.

The heavy surf that beats against the western shore of the island has thrown a bar across the mouth of Grand Cañon, preventing the escape of the drainage water, which forms a pool there. Not far from here, to the south, several detached rocks stand out of the water, near the shore, known as Thimble Rock, Church Rock, and Seal Rock.

Part of the backbone west of Avalon shows its granitic structure, but in proceeding north it is entirely covered by basic lavas. At the Black Jack and Ruby Peaks the formation consists largely of garnetiferous hornblende, although the immediate peaks themselves are composed of volcanic tuff and lava.

About one and one half miles from Black Jack Mountain, to the northeast, is a small, but deep lake—Echo Lake—which seems to fill an old crater. The divide uniting the peaks with the main ridge has been mined, and stringers found containing galena and zincblende. A tunnel fifty-eight feet long runs through the divide near the top, and in it a shaft has been sunk, on one of the stringers, to a depth of thirty-three feet. This tunnel and shaft have been run in micaceous schist.

Leaving Avalon by boat and passing up the east coast of the island, the first large opening in the rocky coast line is at a place called Pott's Valley, about twelve miles from the town; some of the bluffs of trachyte passed between these places rise up from the water to a height of about eight hundred feet. Rock from here has been taken across to be used in making the breakwater at San Pedro Harbor.

On the south side of Pott's Valley a quartzite dike runs down into the ocean, separating the garnetiferous hornblende on the south from the metamorphic slates on the north side 42 degrees east of north. This, from its position and course, might be identical with the quartzite dike seen in Grand Cañon. Along the beach here are found bowlders of hornblende, volcanic tufa, micaceous schists, clay schists, chrome mica, actinolite, and geodes of agate and chalcedony. This part of the island and that north of the isthmus seem to be contemporaneous in age with parts of the main Sierra Nevadas, and from the fact that chrome mica is found here in place with micaceous slates, and has also been found on the coast of the mainland farther south from here, but in the strike of the micaceous slates on the island, it might be concluded that this slate and the slate belt that runs through San Diego County in part were continuous.

On the opposite side of the island, near Little Harbor, in what is known as Cottonwood Cañon, a shaft has been sunk about twenty-five

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feet on a vein one foot wide, showing a little copper stain, but little of anything else. The vein dips to the west about 80 degrees. The walls are micaceous schist. In some of the higher portions of the island where the micaceous schist crops out, remains of Indian mortars made in this material can be seen, evidence of their presence here in numbers.

Passing up the coast from Pott's Valley, bluffs of lava are passed, showing plainly the direction of the flow to have been from around Black Jack Mountain, from where they have flowed into the ocean. The beating surf has washed out large cavities in these bluffs, which, on account of the noise produced by the air confined in them by the water, are known as blowholes. Part of this lava has decomposed into wacke. As on the southwest end of the island, detached rocks a short distance from shore are found here, known as Bird and Seal Rocks. The surf would not permit of a near approach, but they are presumably lava. From this point up to where the United States Survey signal stands on the northeast point of the island, along the coast, considerable money has been expended in mining, but without yielding any beneficial results as far as known.

The first of these exploitations is in a ridge dividing the isthmus from July Harbor. Not far from the beach a drift sixty feet long has been run in on a quartz stringer. The divide on the opposite side of the harbor shows where another drift seventy-five feet long has been run to explore some quartz stringers on that side. Farther inland on this last divide and higher up on the side of the hill is a drift forty feet long on some small veins showing some galena. Several more drifts on both sides of the flat are run in to depths varying from twelve to seventy-five feet; all of these are in micaceous slate. Still higher up the coast, another indentation in the coast line is known as Cherry Valley Harbor. On the south side is a vein of galena and copper sulphides, and, according to statements received, quite a percentage of silver; like all the veins on the island it courses north and south, and has a vertical dip; the vein averages four feet in width. The drift is one hundred and forty-two feet long; the first sixty-nine feet are run in along the wall, then the vein and wall seem to be all broken up; the tunnel then turns to the east and continues about seventy-three feet without finding any further pay. As before mentioned, the isthmus seems at some former period to have been an arm of the sea, that, through erosions on the sides and may be eruptions, has gradually filled in sufficiently to permit of it sanding up. The distance between the slopes of the mountains on both sides is about one thousand feet. The distance across from water to water is barely one half a mile; on both sides the mountains slope towards one another without any connecting ridge. No part of the isthmus here is over forty feet above high-water mark, and in sinking in it for wells it is stated that nothing is met with but made ground, bowlders, sand, and gravel, until at a comparatively shallow depth a brackish water is obtained.

The island above the isthmus appears to be entirely metamorphic schists, containing numerous small quartz veins. The west side has quite a deposit of steatite near the isthmus; some is also found on the east side. Near Johnson's Point, not far from the United States Coast Survey Triangulation Station, about $10,000 have been expended in mining operations, as stated, on what is known as the Beauchey Mine. It is about one mile inland from the landing place. The tunnels that

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have been drifted are stated to be eight hundred feet in length, and quite extensive works were here at one time; now the tunnels are caved and filled with water, and it is not possible to verify statements. The drawing accompanying this has been taken from the United States Coast Survey map, and shows very distinctly the extremely mountainous nature of the island. Before closing I must express my thanks to Mr. Frank Whitley, the oldest resident on the island, for assisting to promote my inquiries while there in every possible manner. As the main mineral interests of Los Angeles County are chiefly centered in her oil wealth, the special article of Ed. North, Esq., on the oil wells of the Pico oil section of Los Angeles County, showing the formations through which the different wells have been bored, and their relative positions to one another, and which will be found in another part of this volume, ought to be of considerable interest and value.

LAKE SALINAS.

Within the town site of Redondo Beach is a small salt-water lake, about three hundred yards from the ocean, and about five feet above the high-water mark, that does not receive its water supply from the ocean, having an entirely different combination of salts, and has about it and its immediate surroundings features that make it of interest to the geologist and chemist.

The lake is about half a mile long, and from four to six feet deep. At the south end is a large shallow basin connected by movable gates with the main lake, which is used for evaporating the water by the heat of the sun. The banks are low, gradually sloping up; a sand dune intervenes between the ocean and the lake; the bottom of the lake is a bed of clay. Around this lake on both sides, about thirty wells have been bored to an average depth of twelve feet into the clay that forms the bottom of the lake, and these all yield a good, soft drinking water. Between these sweet water wells next to the ocean, and the ocean itself, near the top of the dune a well has been sunk to a depth of twenty-six feet, which has passed through the clay for a distance of ten feet. The water obtained in this well is claimed as having medicinal qualities; it certainly tastes bad, if that is any criterion of its medicinal value.

The lake water is a much stronger solution of salts than the water from the open ocean, containing a very much greater proportion of chloride of magnesia; but the statement as made by the parties on the spot to the writer, that the water was ten times as saturated as the sea water, is evidently erroneous, as such a solution would pass the point of saturation. How to account for the presence of these different qualities of water in their relative positions, is not plainly to be seen. The salt water could be accounted for in several ways, as there are beds of saliferous shales and sandstones in the neighborhood; also, there are magnesian rocks on the flanks of the mountains surrounding the plain; but the fresh water in the wells surrounding the lake interferes, from the fact that these wells, terminating in the clay, compel the assumption that the water in them is drainage water from the near vicinity. To solve the question satisfactorily would require a closer investigation into the position of the different strata than the limited time at disposal afforded.

South of the town of Redondo Beach about three miles, the bluffs

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Parallel with the range on the east side of the valley, between Pacoima and Tujunga, there is a canal-like depression between the front and the main ridge that resembles very much a former river bed. On the south side of San Fernando Valley, where the Santa Monica Range forms the southern boundary of the valley, a whitish chalky limestone is found, full of imperfect fish remains, more particularly fish scales and vertebræ; it is in very thin layers. This overlies a coarse, large grained sandstone. The crest of the range is granitic. This chalky limestone may also be seen to the north of the mission.

At the Encino Rancho, where these fish remains seem to be most numerous, there is a warm spring at the base of the hill; it is about 85 degrees, and so alkaline that the water cannot be used for irrigation. It furnishes about five gallons per minute, and according to analysis furnished in United States Geographical Survey West of the One Hundredth Meridian, 1876, by Wheeler, page 195, has in one hundred thousand parts of water:

Sodium carbonate	24.31.
Sodium sulphate	54.46.
Sodium chloride	2.93.
Calcium carbonate	32.17.
Silicic acid	11.50.
Phosphoric acid	Trace.
Sulphuretted hydrogen	Trace.
Potassium	Trace.
Lithium	Trace.
Carbonic acid	In excess.

The writer's attention was drawn to a cinder cone said to exist in the western part of San Fernando Valley, at the edge of the Santa Susanna Range, near the county line, but which could not be located.

THE PICO CAÑON OIL FIELD.

By Edward North.

The Pico Cañon oil field (the oldest and best known oil-producing territory on the Pacific Coast) is situated in Secs. 1 and 2, T. 3 N., R. 17 W., S. B. M., in Los Angeles County. The nearest shipping point is Newhall, seven miles distant, to which point the oil is conveyed by a pipe-line.

The country in which the oil is found is mountainous, the main cañon being cut, by action of water, through the sharply pitched strata which rise precipitously to a height of five hundred to seven hundred feet above the bed of the stream.

With one exception, the oil throughout the entire field is practically of uniform quality, being a green oil of an average gravity of 40 degrees Baumé. The exception referred to is the product of C. S. O. W. Well No. 13, which contains such a percentage of paraffine as to seriously interfere with pumping at times, the paraffine clogging the tubing and coating the sucker-rods to such an extent as to necessitate steaming the entire "string" of tubing. Aside from the presence of paraffine, the product of No. 13 does not differ materially from that of the remainder

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of the district, nor is there any noticeable sign of paraffine in any other well in this field. As No. 13 is upon the western limit of the developed field, however, it is quite possible that an extension of development to the westward might show paraffine to be a feature of the oil in that locality.

The development thus far shows an oil-producing field of a maximum extent of eight hundred and forty feet in horizontal breadth, and three thousand six hundred and sixty feet in length, the oil sand conforming considerably to the general contour of the country. It has been commonly supposed that the oil-bearing sand came to an abrupt termination on the south in a "break" in the stratification, from which "break" croppings indicate that the strata fall away to the north and south at angles varying from 45 degrees to 65 degrees from the horizontal. Late investigations, however, tend to prove the existence in the "break" of a "fault," on the south side of which the oil-bearing sand-rock lies at a greater depth than on the north.

The statistics of drilling operations, while very full as to most of the wells in the district, give but little material upon which to base a theory as to the depth and pitch of the oil sand on the south side of the "break." The only reports bearing upon this point are those of C. S. O. W. No. 8. The first hole drilled here found the oil sand at eight hundred feet below the surface. In attempting to deepen the well, a set of tools was lost in it, which it was impossible to "fish" out. Another hole was then drilled forty feet south of the first, where the oil sand was encountered at eight hundred and fifty feet, showing a pitch of 125 per cent to the south. This seems to establish, beyond a reasonable doubt, the fact that No. 8 was on the south side of the "break." A reference to the cross-section of C. S. O. W. Nos. 8, 18, and 15, Plate 7, shows a fault of five hundred and sixty feet, should the oil sand "A," of No. 8, correspond to the oil sand "B," of Nos. 18 and 15, and eight hundred and ninety-five feet should it correspond to the oil sand "A," of Nos. 18 and 15. As No. 8 was drilled ten feet into a second stratum of oil sand at the time drilling was discontinued (the futility of all attempts to case off water rendering further drilling useless), it would appear that the strata "A" correspond, making a fault of eight hundred and ninety-five feet.

But three productive wells have been drilled on the south side, all of which have been located within one hundred and fifty feet of the probable line of cleavage. Of these, C. S. O. W. No. 8 (the only one finding any thickness of oil sand) was producing fairly at the time it was "plugged," as above stated. P. C. O. No. 11, after being pumped constantly for over nine years, is now (July, 1890) producing 46 per cent as much oil as when first completed; and Hill No. 3, while producing fairly well, was flooded with water through the action of some chemical in the water which ate through the iron casing. Of the two last named, neither show sufficient oil sand to account for its production or staying qualities, P. C. O. No. 11 having but twenty-five feet, and Hill No. 3 none at all.

Both got their oil in "shells," a term by which oil drillers designate thin laminæ of sand and shale alternating with a hard, impervious rock. Both of these wells being so close to the probable line of the "break," it seems quite likely that they have drawn their oil supply, through these shells, from the large body of oil sand on the north side (see Plate 11).

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Of the five "dry holes" drilled on the south side, Nos. 10, 11, and 16 (C. S. O. W.) all failed to go deep enough to strike the main oil sand, conceding a fault of eight hundred and ninety-five feet, and a dip of 125 per cent. While Nos. 10 and 16 both found a little oil, it seems quite probable that this leaked through some crevice from the oil sand on the north side of the "break," as shown in Plate 9. As to the remaining wells (Hill Nos. 1 and 2), there is no formation reported sufficient to diagram, nor are there sufficient data regarding the north side of the "break" at this point to give any reliable clew to its location.

On the north side of the "break," the greatest horizontal breadth of the developed field is from C. S. O. W. No. 2 (which is supposed to be almost in the line of cleavage) to C. S. O. W. No. 9, a distance of eight hundred and forty feet (see Plate 9). Following the angle of the oil sand, this would give, between the points pierced by these two wells, an actual breadth of oil sand of one thousand five hundred and fifty feet. The average dip of the formation on the north side of the "break" is 161 per cent on the C. S. O. W. territory, and 165 per cent on the P. C. O. Conceding a uniform breadth of oil sand of one thousand five hundred and fifty feet, and figuring the pitch at the proper angle where known, and the average where unknown, a breadth of field is established (see map) which is thought to be sufficiently conservative in its estimate to be practically reliable. That the field is broader than the one thousand five hundred and fifty foot line shows, is extremely likely, as the average vertical thickness of the oil sand in the wells along the north line of the developed field (Plate 1) is two hundred and fifty-four feet, with no marked indications of its "pinching out." But two wells have been drilled far enough north to raise any question on this point: P. C. O. Nos. 7 and 12. No. 7 was drilled to a depth of two thousand four hundred and twenty feet below the datum line, and found but slight traces of a black oil. Lines run from Nos. 9, 3, and 18 (P. C. O.) to No. 7, intersecting the line from Nos. 5 to 6, show, from their respective wells to the points of intersection, dips of 213 per cent, 163 per cent, and 280 per cent. Extending these lines on the same angles to No. 7, they give, as the average depth below the datum line at which the oil sand should have been found, two thousand four hundred and thirty-five feet. As the well was drilled to two thousand four hundred and twenty feet only, there is a fair probability that it did not go deep enough to thoroughly test the matter.

P. C. O. No. 12 seems to have been drilled to a sufficient depth could we be assured that the dip of the oil sand did not exceed 165 per cent; but having no producing well opposite No. 14 from which to draw a logical conclusion as to the dip, and noting a dip of 230 per cent from P. C. O. No. 13 to No. 6, it seems quite possible that this same pitch should prevail farther east, throwing the oil sand to a depth of one thousand eight hundred and ninety-one feet below the datum line at No. 12, while that well was drilled to a depth of but one thousand eight hundred feet.

As shown in Plates 1 and 3, there is a stratum of very light oil overlying the main body of oil sand in C. S. O. W. Nos. 6, 12, 13, 15, 17, and 18. The distance between the two strata varies from one hundred feet in No. 13 to three hundred and thirty feet in No. 18.

C. S. O. W. No. 14 had a slight showing of this light oil, but drilling was suspended when but three hundred and fifty feet below it. It does

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not seem impossible that a few feet farther might have found the main oil sand.

C. S. O. W. No. 17 would have been drilled deeper but for a body of quicksand which caught a bailer and rushed into the hole in such quantities as to effectually prevent "fishing" it out.

P. C. O. No. 15 (Plate 6) found the oil sand at a proper and consistent depth, as compared with Nos. 3, 13, and 14, but it being impossible to "case off" water, owing to the seamed or porous nature of the rock, the oil was forced back into the sand, and the well has never been a producer.

A careful study of the above facts seems to confirm the belief entertained by the owners of the property, that the limit of the field has not been reached in any direction.

Regarding the accompanying plates, it is necessary to say but little, for, as a rule, they are self-explanatory. All of the longitudinal sections show that there is but one stratum that is continuous from one end of the field to the other, viz.: the main body of oil sand. The cross-sections illustrate the very heavy fall from the "break" in each direction.

Plate 1. The most noteworthy features of this plate are the "floating" strata in C. S. O. W. No. 15 and P. C. O. Nos. 5 and 6, the peculiar undulations of the oil sand (which, however, are noticeable in all of the longitudinal sections), the deep "gouge" between Star No. 1 and C. S. O. W. No. 9, and the sudden change from the large body of sand and shale in P. C. O. No. 5 to the immense thickness of sand in P. C. O. No. 6.

Plate 2. This plate is noticeable on account of the many floating strata, the sudden change at the boundary line between the P. C. O. and C. S. O. W., from a formation of sand, shale, and shells to a body of solid sand, and the peculiar contractions and expansions of the oil sand.

Plate 3 shows, as its most salient features, the great thickness of oil sand in C. S. O. W. No. 7, the great contraction between No. 7 and P. C. O. No. 8, and the expansion from No. 8 to No. 9.

Plate 4 shows much the same characteristics as Plate 2.

Plate 5 shows a stratum of sand and shale in the midst of the oil sand in C. S. O. W. Nos. 1 and 2. As these wells are nearly or quite in the line of the "break," it seems not unlikely that a body of sand and shale from the south side has been forced into the oil sand on the north side in the manner shown in Section 2, Plate 8, and Section 1, Plate 9.

Plate 6 is noticeable chiefly for the great thickness of oil sand in P. C. O. No. 13, and for the stratum of barren sand diagrammed as being wedged into the oil sand in P. C. O. Nos. 14 and 15. That the first stratum of oil sand in No. 14 is a part of the main body seems likely, from the fact that when the drill was but eight feet into it, the hole filled up two hundred feet with oil, and when the lower stratum was tapped it produced an unusually large amount of oil, considering the thickness of oil sand pierced, thus arguing a connection, at no great distance, with a larger body of the oil-bearing rock.

Plate 7 requires no especial explanation other than that of Section 3, which has been given above.

Plate 8 requires no explanation other than that given of Plate 5.

Plate 9. A very peculiar feature of Section 2 of this plate is the steep, downward pitch from P. C. O. No. 20 to No. 1, the following slight ascent from No. 1 to No. 8, and the ensuing rapid decline to No. 4. This

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seems to indicate a minor fault between No. 1 and No. 8. There is, so far, no evidence of this fault extending to any other portion of the field.

PLATE 10 contains nothing worthy of especial notice.

PLATE 11 is noticeable chiefly for the enormous thickness of oil sand in P. C. O. No. 13. The theory as to P. C. O. No. 11 and Hill No. 3 drawing their oil from this body of sand has been fully explained above.

PLATE 12 shows in full detail the formation encountered in drilling C. S. O. W. No. 19 by the diamond drill process. The attempt to utilize this process in the drilling of oil wells was made in the summer of 1889, and was referred to in the report for that year. This process possesses the following advantages over the ordinary rope-tool process, viz.: there is no difficulty in drilling a perfectly round, straight hole; there is comparatively no trouble from "fishing jobs;" and the cores taken out give a remarkably clear insight into the formation and dip of the stratification. In solid, hard rock its work is rapid, but in the shale formation of this field its progress is much slower than that of a walking-beam rig. The main objection to it, as shown in this field, however (and one which seems, at present, to be insurmountable), is that the water used in washing out the drillings seems to have forced the shale drillings into the pores of the oil sand, cementing it up so tightly as to prevent, to a great extent, the oil from oozing into the hole.

In conclusion, it might be well to state that croppings indicate that this field extends in a westwardly direction from half to three quarters of a mile and apparently ends abruptly on the Rancho Simi. A well drilled on this ranch, however, failed to get any oil. To the eastward, croppings and oil seepages indicate a probable extension of the field of not less than six miles in this direction.

The field is controlled and operated by the Pacific Coast Oil Company and the California Star Oil Works Company.

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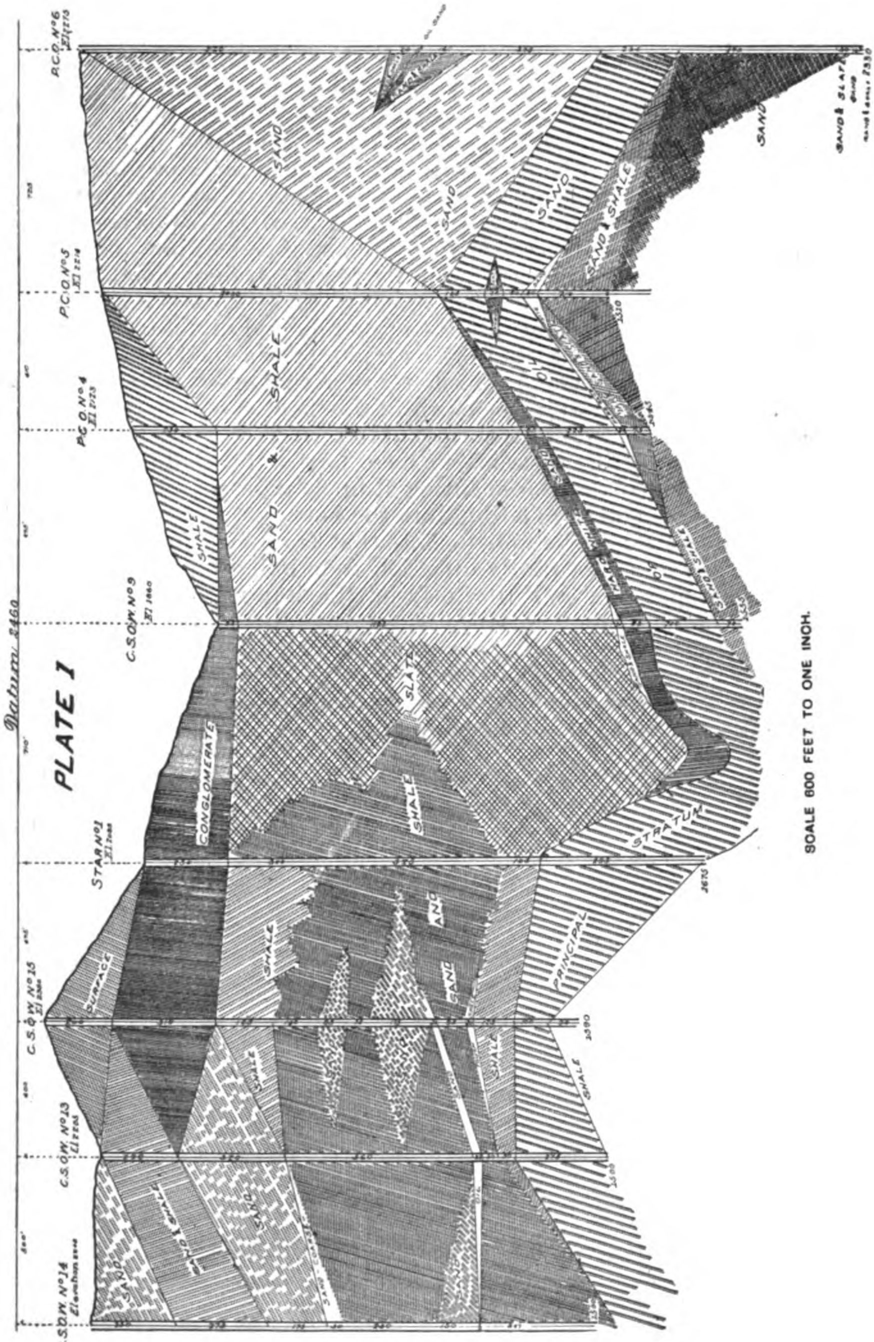

PLATE 1

SCALE 600 FEET TO ONE INCH.

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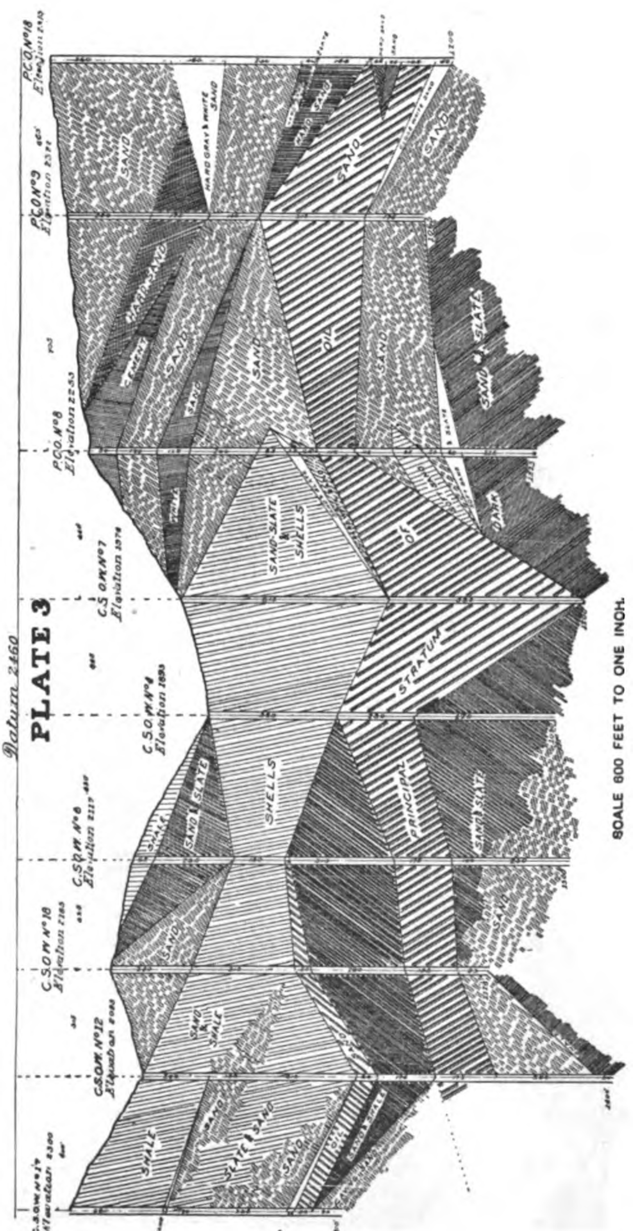
Section through line A.B of Map.
Datum 2460
C.S.O.W.Co.
PLATE 2
P.C.O.Co.
Boundary line
SAND SHALE & SHELLS
SHELLS & SHALE
SAND
SHALE
SAND & SHALE
CONGLOMERATE
OIL
OF
STRATUM
SCALE 600 FEET TO ONE INCH.


Datum 2460
PLATE 3
SCALE 600 FEET TO ONE INCH.
PRINCIPAL
OIL
STRATUM
SHELLS
SAND-SLATE & SHELLS
SHALE

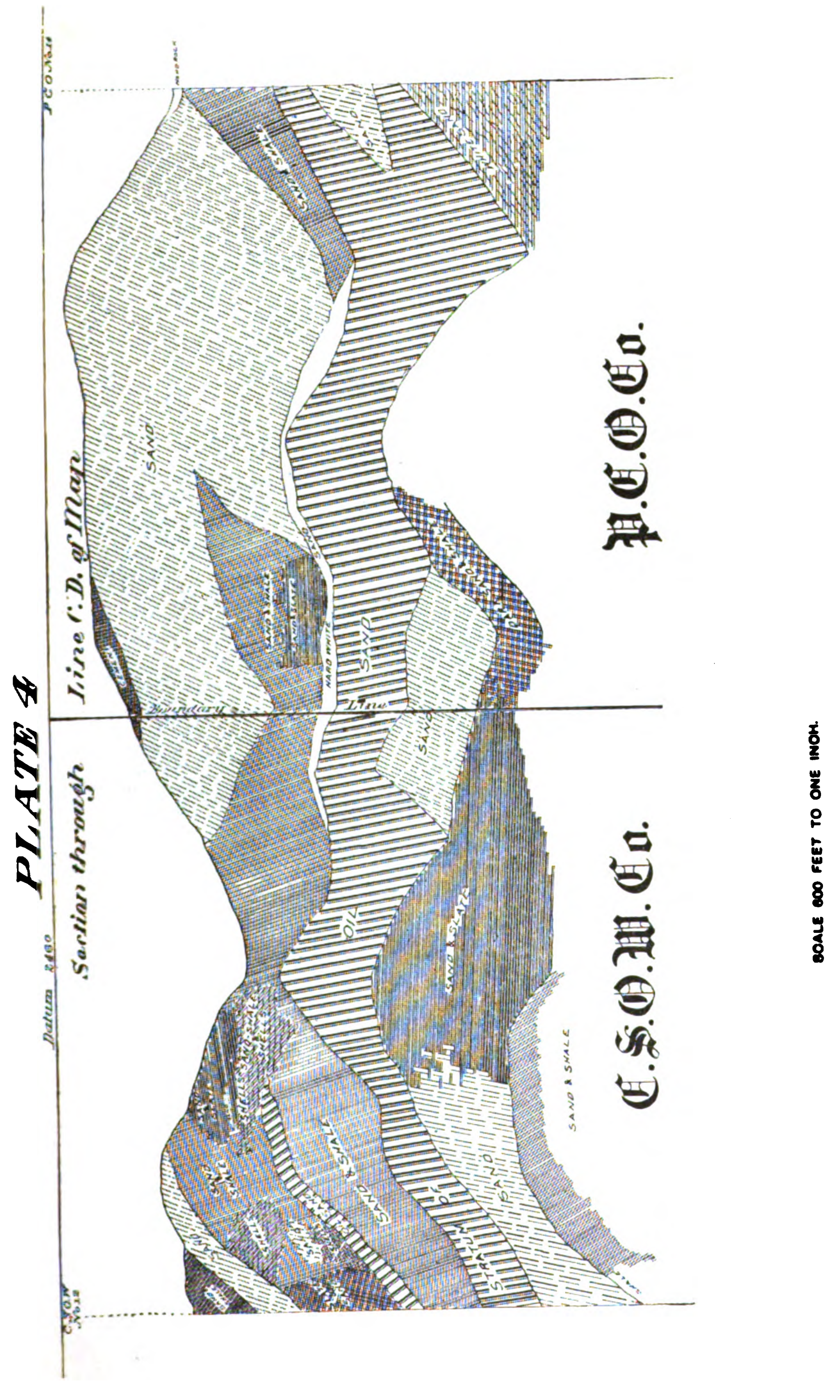


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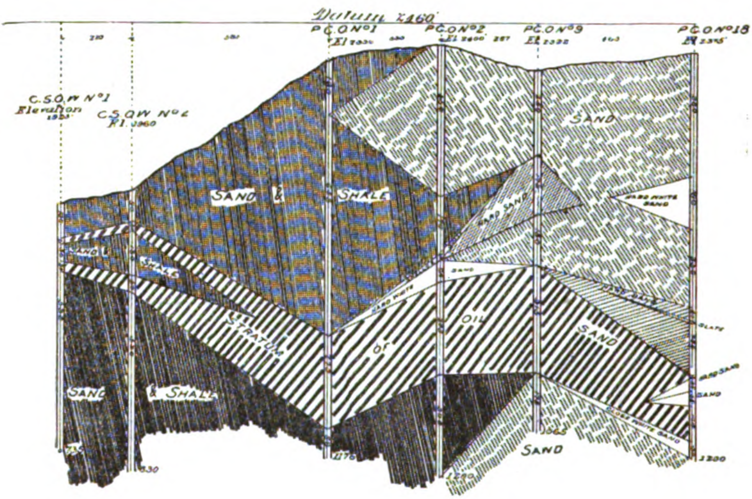
PLATE 5



SCALE 600 FEET TO ONE INCH.

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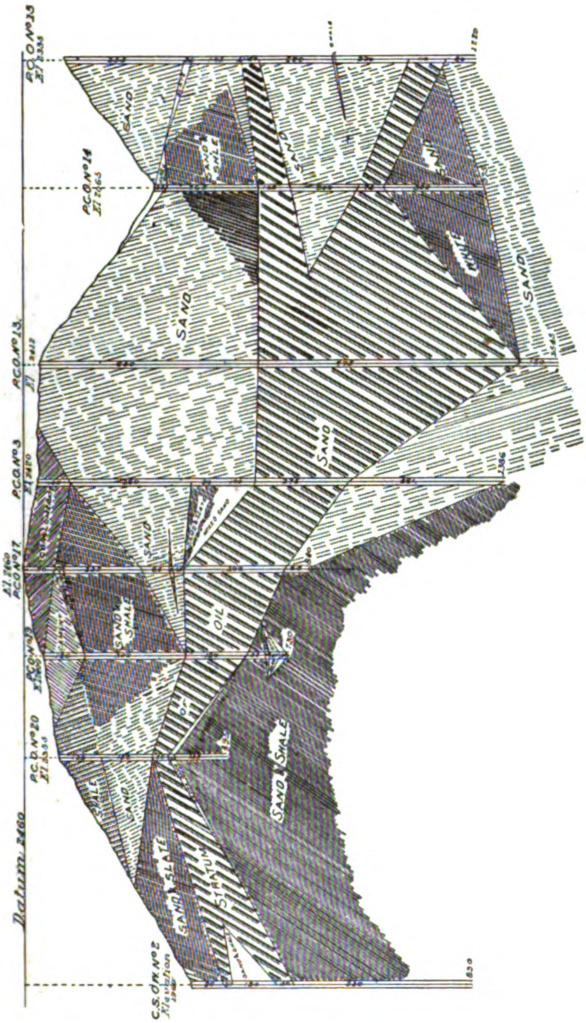
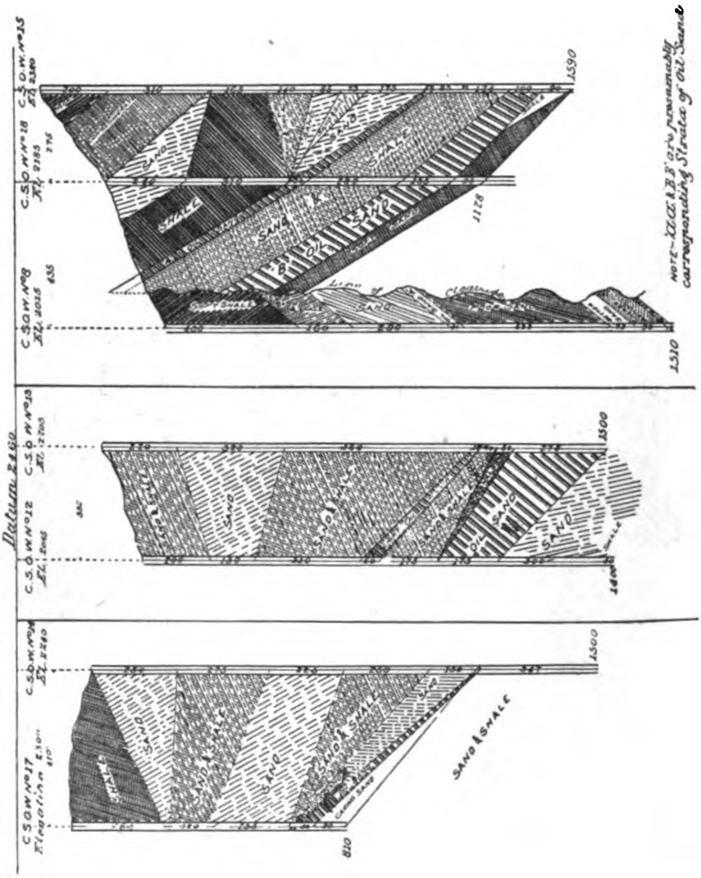
PLATE 6



SCALE 600 FEET TO ONE INCH.

PLATE 7



SCALE 600 FEET TO ONE INCH.

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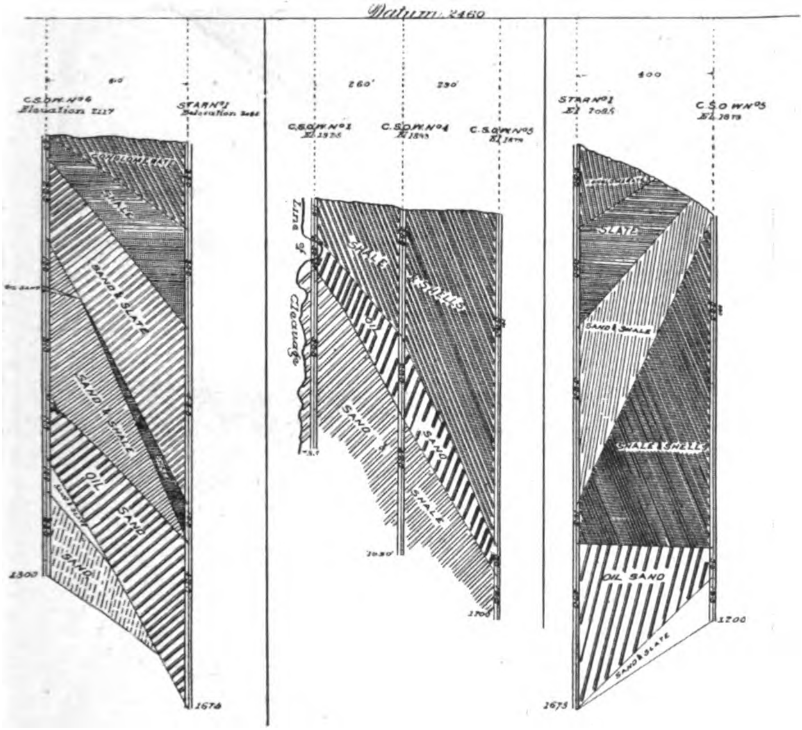
PLATE 8



SCALE 400 FEET TO ONE INCH.

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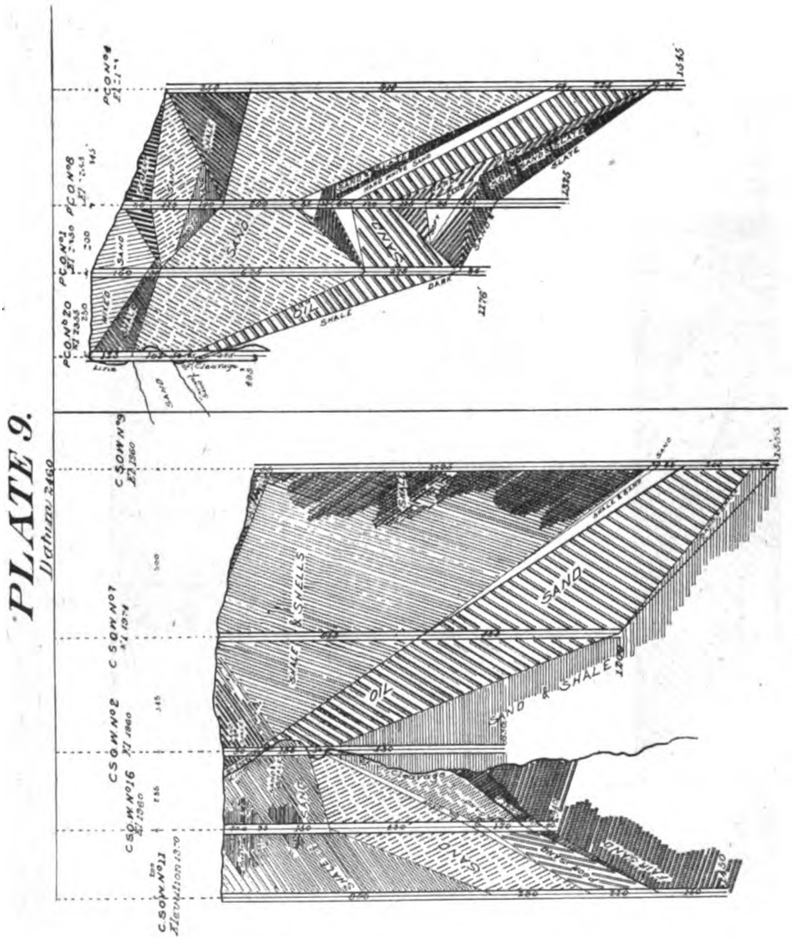


SCALE 400 FEET TO ONE INCH.

PLATE 10.

Datum 2460

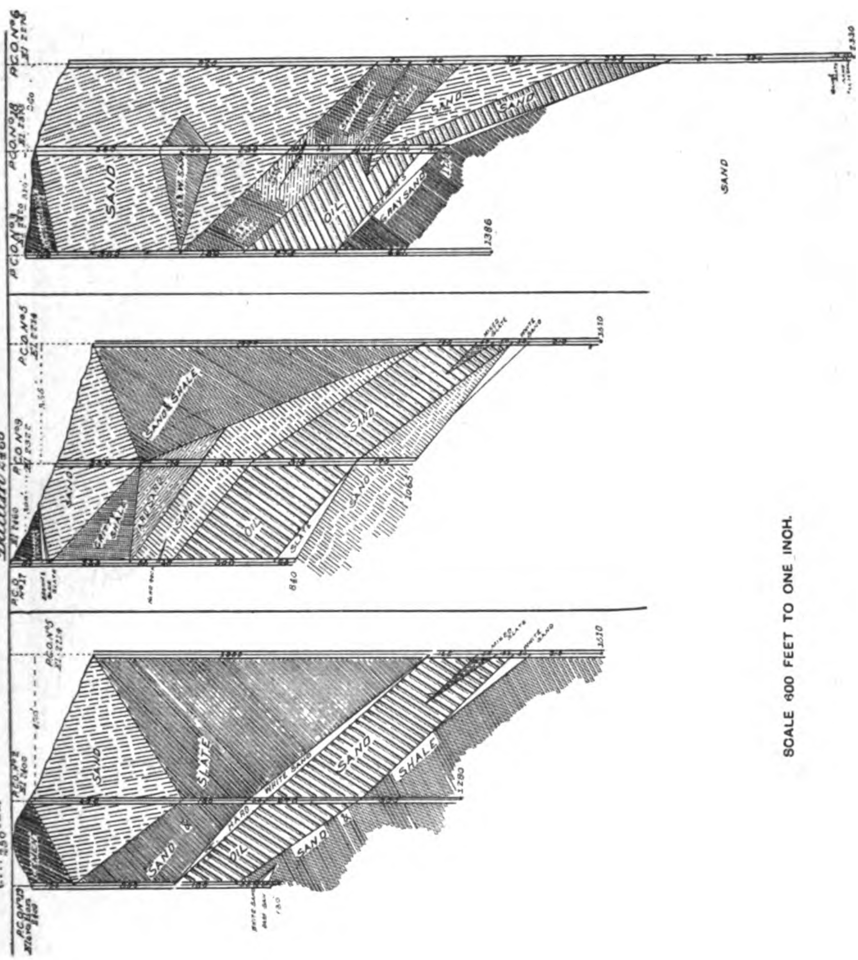
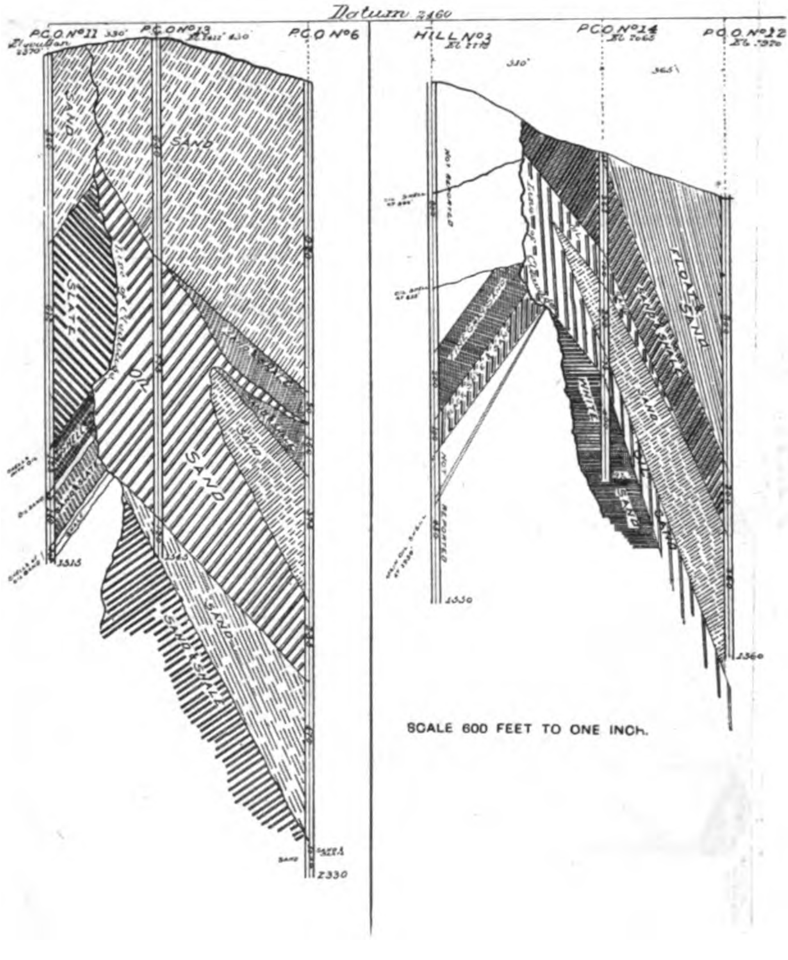


PLATE II



SCALE 600 FEET TO ONE INCH.

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PLATE 12

CALIFORNIA STAR OIL WORKS CO.

Elevation 2027 ft

NO 19.

SURFACE	5	
SHALE	20	
SHALE WITH A LITTLE SAND	25	
SAND AND COBBLES	21	
SAND ROCK SOME QUITE HARD	33	
SHALE	6	
STICKY SHALE	10	
SHALE WITH SOME OIL	12	Some oil
SHALE SMALL STREAKS SAND	13	
SHALE	60	
SHALE SMALL STREAKS OF OIL SAND	20	Oil
SHALE	97	
SHALE & OIL SAND	10	oil
SHALE	33	

SHALE SMALL STREAKS OF OIL SAND	20	Oil
SHALE & OIL SAND	15	Oil
SHALE	14	
SHALE MIXED WITH SAND	12	
SAND AND SHALE	28	Considerable oil
SHALE	6	
SAND AND SHALE	11	
GAS & OIL	3	Oil
SHALE WITH STREAKS OF OIL SAND	28	Oil
SHALE	18	
SHALE AND OIL SAND	30	Oil
SHALE	10	
SHALE WITH STREAKS OF OIL SAND	47	Oil
SAND AND SHALE	23	
COBBLES	28	Little Oil
SAND & SHALE	26	Oil
SAND CONGLOM. SOME OIL SAND	47	Oil
STREAKS OF HARD SAND	37	Some oil; Little oil
SAND & BLK SHALE	10	

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MARIN COUNTY.

By W. A. Goodyear, Geologist, and Assistant in the Field.

The rocks along the line of the railroad from Tomales to Point Reyes Station seem to be entirely metamorphic, chiefly sandstones and shales, in which the stratification is generally obliterated or obscure. In a few places, however, the stratification could be seen, and where that was the case the strike appeared to be northwesterly and the dip northeasterly. In some places, also, there is considerable serpentine.

From Point Reyes Station to San Rafael the rocks continue to be of the same general character.

A trip was made some ten or twelve miles southwesterly from San Rafael to Bolinas Summit, the altitude of which above the sea was claimed by the man who lives there to be one thousand five hundred and seventy-five feet, although, according to the aneroid at the time of my visit, it would have appeared to be only about one thousand four hundred feet.

All the rocks seen on this road are metamorphic, blocky, and rotten sandstones and shales, with here and there some very hard sandstones and occasional patches of serpentine.

In the southwestern edge of the town of San Rafael, a quarry has recently been opened of a white trachytic rock, which is now being used for the pavement of street gutters in some parts of the town. This rock occurs in the form of a dike from fifteen to twenty feet thick so far as exposed, striking nearly east and west and standing nearly vertical. The dike is inclosed on both sides between very smooth walls of blue, metamorphic, but not very hard sandstone containing considerable lime, and essentially similar in character to the sandstone of Angel Island, of which the Bank of California is built. The trachyte itself has evidently been considerably altered since its intrusion. It is not very coarse-grained, but is highly crystalline and compact, and is filled with small particles of iron pyrites thickly scattered through it. It is still a pretty hard rock and will probably answer well the purpose for which it is being used. But long exposure to the air will, of course, cause the iron pyrites to decompose and stain it with iron rust.

At a locality near Novato, and about half way between San Rafael and Petaluma, there is in the hills to the west of the road, but not far from it, a considerable outburst of basalt, which has furnished great quantities of street-paving blocks and from which, also, was obtained the stone of which the retaining wall about the residence of Gov. Leland Stanford was built. The same stone from the same quarry was also very largely used in the construction of the residence built by Mark Hopkins on the western part of the same block, bounded by Powell, California, Mason, and Pine Streets. It is, of course, a hard and very costly stone to cut, but it is among the most durable of all known rocks, and will outlast a great many generations of men.

This is the only locality of basalt yet known to exist in Marin County.

Very few rocks are visible along the railroad from San Rafael to Saucelito, but those seen appeared to be all metamorphic sandstones, etc.

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MARIPOSA COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

As the geology of the Mariposa Grant will be treated in a special article by Mr. Fairbanks, and as the time at the writer's disposal during his recent visit to this county was extremely limited, his observations were mainly confined to those mines outside of the grant in the near neighborhood of the town of Mariposa, leaving the other sections for a future examination. The grant mines, which are by far the most important in the county, are not being operated at present.

In approaching Mariposa on the stage road from Merced, the writer thought he could perceive in several places adjacent to the road physical features in the appearance of the hills, the bowlders, and the placer grounds that exhibited glacial action. Especially was the rounding off of the hilltops, composed of upturned slates, characteristic, as one or the other side would retain the sharp croppings of the slate standing on edge, while the other part would be smoothly rounded off. The bowlders, too, had the peculiar shape and, in some instances, markings similar to those found among the moraines.

BEAR VALLEY OR MALONE MINE.

This mine lies in Sec. 4, T. 5 N., R. 19 E., M. D. M., at an altitude of two thousand seven hundred feet above sea level, about five miles southeast from the county seat, Mariposa. It comprises one hundred acres of patented land, and was located in 1880. The vein, which is from one and a half to three and a half feet in width, courses north 35 degrees west, and dips to the west at an angle of about 35 degrees. The walls are granite, the hanging wall showing a very distinct concentric structure, with a darker color than the foot wall. Next to the vein, in places, thin strata of chloritic slate are found, and the owner stated that he had found pieces in the granite of the hanging wall. The formation of the country shows a granitic basin surrounded on all sides by chloritic slate. The extent of the basin is about three quarters of a mile in diameter. A small creek runs around at the foot of the hill, which has been worked formerly as a placer, and has yielded quite large specimens of gold in the neighborhood of the mine. The present workings are confined to an incline shaft which is being sunk on the vein, and has reached at present a depth of two hundred feet, from which drifts will be started. The owner thinks by following on the pitch of the vein, the next hundred feet of the shaft will bring him out of the granite into the slate, and show the continuation of the vein beyond the contact. As far as this part of the county has been observed, it would appear that all the mines are more or less in bonanza immediately under the grass roots, and the denudation and erosion of these flat-lying veins have supplied the great amount of shallow and rich placers that have been worked here since early times.

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The vein of the Malone Mine belongs to the ribbon quartz variety, and shows the upper half to have been more under the influence of oxidation than the lower part, as the sulphurets, of which there is quite a percentage, are decomposed in this part, staining the quartz an ocher color, while next to the foot wall they retain their original condition. The mill, which is connected with the shaft by tramway, was being overhauled; it is calculated to crush about ten or twelve tons per twenty-four hours. Amalgamation in battery and on plates is practiced, and the sulphurets are saved on blankets. This latter operation is expeditiously carried out by hanging the blanket sluices on pivots acting lengthwise with the sluice, and beneath the two sluices, which are set side by side, is a V-shaped sluice with considerable pitch leading to a tank. To clean the blanket, which is fast in the sluice, the latter is tipped inward over the V sluice and the hose played on it. Then it is returned to its place. The mill machinery is run by a three-foot Pelton wheel under a head of one hundred and fifty feet. The hoisting is effected by a horse-whim.

Elevation above sea level	2,700 feet.
When located	1880.
Dimension of claim	100 acres, patented.
Mining district	Mariposa.
Name of nearest town	Mariposa.
Direction and distance from town	5 miles northeast.
Distance from nearest railroad	25 miles from Raymond.
Cost of freight from railroad to mine	1¼ cents per pound.
Cost of freight from San Francisco to railroad station	47 cents per hundred.
Course of vein	Northwest 35 degrees.
Direction of dip of vein	West.
Degrees of dip of vein	35 degrees to 40 degrees.
Average width of vein	20 inches to 3½ feet.
Formation of walls	Both granite.
Tunnel or shaft	Both.
Number of tunnels	1.
Cost per foot running tunnel	$4 per foot.
Vertical depth from surface reached in tunnel	110 feet.
Length of tunnel timbered	All the way.
Dimensions of tunnel	6 feet by 4 feet.
Formation passed through	Granite.
Number of feet run per shift	3 feet.
Length of ore shoot	350 feet; end not yet reached.
Number of shoots being worked	1.
Greatest length of ground stoped	350 feet.
Pitch of ore shoot	North.
Number of air shafts	2.
Depth of air shafts	30 feet and 75 feet.
Kind of timber used	Pine.
Cost of timber	Owned by company.
Shafts	1, incline on vein.
Depth of shaft on incline	200 feet.
Vertical depth of shaft reached	140 feet.
Number of levels	2.
Length of level No. 1	275 feet.
Length of level No. 2	75 feet.
Quantity of water coming in	150 gallons per hour.
Kind of pump used	2-inch Hooker.
Kind of drill used	Hand drill.
Kind of powder used	Giant No. 2.
Quantity of powder used per ton of ore extracted	1 pound per ton.
Amount of glycerine in powder	42 per cent.
Cost of mining per ton of ore	$2 50 per ton.
Dimensions of shaft	11 feet by 6 feet.
Number of feet sunk per shift	1 foot per 8-hour shift.
Formation passed through	Granite.
Distance from mine to timber	On the ground.
Source of timber	Property of the company.
Cost of timber	3 cents per foot.
Distance from mine to lumber	12 miles to Snyder & Co.'s mill.
Cost of lumber	$25 per thousand.

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Length of road built by company	¼ mile.
Length of ditches built by company	2; 12 miles and 2 miles.
Cost of ditches	$13,000 and $3,000.
Cost of transporting ore to works	12 cents per ton.
Character of ore	Free-milling ribbon quartz, with 3 per cent sulphurets.
Method of treating ore	Amalgamation in battery and on plates.
Description of mill and works	8-stamp mill, run by Pelton wheel.
Number of stamps	8 stamps.
Weight of stamp	650 pounds.
Drop of stamps in inches	6 inches.
Drops per minute	85 per minute.
Height of discharge	5 inches.
Duty per stamp—tons crushed in twenty-four hours	1¼ tons.
Kind of metal used for shoes and dies	White iron.
Cost of shoes and dies per pound	6 cents per pound.
Wear of shoes and dies	700 tons to 1 set.
Quantity of water used in battery	½ inch.
Battery screen	No. 45 round-punched.
Dimension of screens inside of frames	3 feet 4 inches by 6 inches.
Vertical or inclined	Inclined.
Plates, size of apron	4 feet 4 inches by 3 feet 5 inches.
Width of plates in sluice	28 inches.
Length of plates in sluice	16 feet.
Size of plates inside of battery	12 inches by 42 inches.
Copper or silvered plates	Silvered.
Inclination of plates—inches to the foot	1 inch to 1 foot.
Kind of feeders used	Home-made self-feeders.
Percentage of value saved in battery	75 per cent.
Percentage of value saved on plates	20 per cent.
Quicksilver used per ton of ore worked	4 ounces.
Quicksilver lost per ton of ore worked	2 ounces to every ounce of gold.
Name of concentrator	Blankets.
Sulphurets, percentage of	3 per cent.
Nature of sulphurets	Iron pyrites with some galena.
Value of sulphurets per ton, in gold	$300 to $1,700 per ton.
Method of saving	Blankets.
Number of men employed in mine	7 men with foreman.
Number of men employed in mill	2.
Number of men employed on outside work	3.
Total number of men employed	12.
Average wages paid per day in mine	$3 00.
Average wages paid per day in mill	$3 50.
Average wages paid per day on outside work	$2 50.
Kind of water power	Pelton wheel 3 feet in diameter; 150 feet of pressure.
Species of wood used	Nut pine and oak.
Cost of wood, per cord	$2 75 and $3.

During the last year the company has cleared out four hundred feet of an old tunnel, sunk the shaft one hundred and fifteen feet, repaired and renovated their mill, bought and put in place five hundred feet of ten-inch pipe, repaired and partially flumed twelve miles of water ditch. For the coming year the company will replace their horse-whim with an engine, take out the old stamps and put in ten heavier ones; put in three quarters of a mile of pipe to save six miles of ditch, add concentrators and self-feeders to the mill, continue to sink the shaft, and drive levels both ways at every sixty feet. The rock in this mine averages about $14 per ton, the gold being worth from $17 50 to $18 per ounce.

Some parties have taken up an extension on this mine, but are not working it at the present time.

CHAMPION MINE.

Four and one half miles from town to the north, in a chloritic slate country, exploitations have been made on a large quartz vein coursing east and west, and dipping almost vertical; it varies four feet in ninety feet from the perpendicular; it is known as the Champion Mine, and is

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a contact vein between the slate and diabase. A double compartment shaft four feet by ten feet has been sunk on the vein to a depth of ninety feet. At sixty feet, and at the bottom the vein has been drifted on; the hoisting is done by steam, using a three eighths inch steel wire. The property is located on Sec. 34, T. 4 N., R. 18 E., is a full claim one thousand five hundred feet by six hundred feet, in Colorado Mining District, and belongs to parties here and in Chicago. It has an altitude of three thousand four hundred and fifty feet. West of the shaft the vein was split by a horse fourteen feet wide. The drifts were run on the vein on both sides, and about five hundred tons in all have been taken out that, according to tests made in the hornspoon and by hand-mortar working, will average over $12 per ton. The quartz is a white, somewhat glassy, ribbon quartz, with iron sulphurets and galena. Two pay shoots are known to be on the claim; the second one lies west of the present workings. Although everything appears to be here necessary for a successful mine, nothing is being done for lack of harmony between the California and Chicago owners of the property. An interesting geological feature is to be seen about one hundred yards from the mine, consisting in an intrusive granite dike cropping out not more than six or eight feet wide, running about parallel with the quartz vein, and traceable for several miles.

Altitude of mine	3,450 feet.
When located	1887.
Dimensions of claim	1,500 feet by 600 feet.
Mining district	Colorado.
Name of nearest town	Mariposa.
Direction and distance from town	North, 4½ miles.
Direction and distance from nearest railroad	East, 42 miles.
Cost of freight from railroad to mine	$1 37 per hundred.
Cost of freight from San Francisco to railroad station	47 cents per pound.
Course of vein	East and west.
Direction of dip of vein	North.
Degrees of dip of vein	Almost perpendicular.
Average width of vein	Four feet.
Formation of hanging wall	Diabase.
Formation of foot wall	Chloritic slate.
Tunnel or shaft	Shaft.
Cost per foot running tunnel	$3 per foot.
Dimensions of tunnel	6 feet by 4 feet.
Formation passed through	Drifted on vein.
Number of feet run per shift	3 feet.
Length of ore shoot	Not proved.
Kind of timber used in mine	Sawed timber.
Cost of timber	$21 50 per thousand.
Shafts	Vertical.
Depth reached in feet	90 feet.
Number of levels	4.
Length of level No. 1	60 feet.
Length of level No. 2	80 feet.
Length of level No. 3	70 feet.
Length of level No. 4, crosscut	14 feet.
Quantity of water coming in	1,760 gallons per day.
Kind of drill used	Hand drill.
Kind of powder used	Giant No. 2.
Quantity of powder used	420 pounds in six months.
Amount of glycerine in powder	42 per cent.
Cost of mining per ton of ore	50 cents per ton.
Dimensions of shaft	4 feet by 10 feet.
Number of feet sunk per shift	10 inches per shift.
Formation passed through	Slate.
Distance from mine to timber	One half mile.
Source of timber	Government land.
Cost of timber	4 cents per foot.
Distance from mine to lumber	14 miles, Snyder's Mill.
Cost of lumber	$21 50.
Means of transporting ore to works	Tramway.
Character of ore	Free-milling gold quartz.

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sunk forty feet on the vein, but no drifting has been done so far. Two men are working the mine, and get their quartz crushed in a five-stamp mill situated about one half a mile away, belonging to other parties. The yield up to date has averaged $25 per ton, the gold being worth $17 50 per ounce. Years ago a French company started in to develop this property, but abandoned it, presumably on account of the smallness of the vein.

BREEN MINE.

Seven miles north of Mariposa. A number of parallel blanket veins dipping west 20 degrees, and having a north and south course, constitute the Breen Mine. They are in porphyry, decomposed, and the whole mass is washed through sluices. The quartz in the tailings assays $13 per ton. It is worked by the owner alone, who has worked it to a depth of twenty-five feet. He owns two miles of ditch, taking the water from Mullin's ditch. He uses thirty miner's inches of water under a sixty-foot pressure. He picks and blasts the rock and dirt down, and then turns the water on it, running through ten or eleven sluices that have a grade of one and a half inches to the foot. Slat riffles are used. The water season lasts from three to five months. There are thirty or forty such blanket veins in sight, from the thickness of a knife blade to two feet. All of them have more or less gold in them.

SEBASTOPOL.

East of south about four and a half miles from Mariposa, in Sec. 33, T. 5 N., R. 19 E., passing up Mariposa Creek, past the Big Springs, after passing through a diabase belt, appears a granitic region, after crossing which a slate and gneissic range is reached, in which the Sebastopol Mine is situated. It is at an altitude of two thousand eight hundred and fifty feet, coursing almost due north and south, and with vertical dip. The walls are fibrous gneiss, while the vein matter is micaceous slate, with a dip of 40 degrees to the south. In this slate stringers and seams of quartz are found coursing in the same direction as the main fissure and with the same dip. In these quartz veins the gold is found. It is what is known as a pocket mine, and for short distances this quartz becomes extremely rich, yielding sometimes several thousand dollars within a distance of a few feet. The gold is extremely coarse, worth over $20 per ounce. This pocket quartz is worked by hand mortar. Lying west of this fissure about three hundred feet is another quartz vein, more distinctly defined, also between gneiss walls. It has but little gold, and is not worked by the owner. The quartz is in the nature of ribbon quartz. The mine, which is also known by the name of the Hart Mine, that being the owner's name, is leased to two different parties, one working the north, the other the south end. Considerable work has been done on this ground in former years, and many rich pockets uncovered; one of these yielded one thousand two hundred pounds of ore, worth $17,000.

These old workings are all closed in now, and the present works at both ends are in entirely new ground. To the east of the mine is a granite belt four miles wide. The entire surface of the hill on which the Sebastopol is situated yields more or less gold; also the gulches around the foot of the hill.

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Number of men employed in mill	1.
Total number of men employed	3 to 4.
Nationality	Caucasians.
Average wages paid per day in mine	$2 50.
Average wages paid per day in mill	$3.
Kind of power	Steam, 12-inch cylinder.
Cords of wood used per day	1½.

The company is going to timber the main shaft, sink it fifty feet further, and prepare ground for stoping.

THE HAYSEED AND FARMERS HOPE.

These two claims are adjoining each other, and can be considered together. The work carried out is more in the nature of prospecting after a chimney, most of the veins in this district belonging to that class of mineral deposits. The vein courses east of north about 30 degrees, and dips to the east at an angle of about 40 degrees; the vein is small, not averaging more than ten inches to fourteen inches, and is incased between slate and diabase walls. They have both tunnels and shafts. On the Farmers Hope is a tunnel one hundred and ten feet long, reaching about sixty feet perpendicular under the surface; the cost of this tunnel was $2 per foot, and for a distance of eighty feet the ground has been stoped, and the ore shoot pitches to the south. The cost of mining at the Farmers Hope is about $3 50 per ton, while at the Hayseed, under the present method, it amounts to $20. Such mining requires a bonanza to be able to be continued. The mines are worked intermittently. Should a bonanza be struck and worked out roughly, work is dropped entirely for a time until it is found expedient to once more look up the neglected source of the income. Under such a system permanent works and a good mining plant can hardly be expected. At the time of the writer's visit the Farmers Hope had on the dump about one hundred tons of quartz that will average $15 per ton, while the Hayseed could show ten tons of $50 ore, and the outlook was encouraging for the grade to go up still higher. These mines are all in the same section, township, and range as the Triumph. They take the ore to the Triumph Mill to be crushed, for which they pay $4 per ton. The Farmers Hope owners have a furnace at the mouth of the shaft to draw off the foul air, and intend to put up a small steam hoist, when they will drift on the vein both ways from their shaft.

Continuing along the creek on the road back to Mariposa, about one half mile from the Triumph Mill a five-stamp mill is situated close to the road, belonging to the Alabama Mining Company. The mine is still farther beyond one half mile, and shows a well appointed steam hoisting works over a large shaft. Neither mine nor mill were in operation, the partners having cleaned up their mill the day previous and were taking their bullion away.

Another mining property, patented, but lying idle at the time of the visit, is known as the Whitlock Mine.

Between the Alabama Mine and mill, but on the opposite side of the road, is

THE PEREGOY AND HEISER MINE.

At present it is under a bond. It is in the same section and township as the previous mines, and shows a well defined prominent vein eight feet wide, coursing north and south, and dipping slightly to the east.

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The vein is worked through a shaft four feet by seven feet, and sixty feet deep, the hoisting being performed by a horse-whim. A drift has been run from the bottom of the shaft to the north a distance of twenty feet, and a stope started. The wall rocks are slate; the quartz is ribbon quartz, with one half per cent of sulphurets, mostly iron and galena. As far as tested, the ore will average $15 per ton. A body of water was encountered while at work in the bottom, furnishing two thousand six hundred gallons in twelve hours. Operations are suspended pending the placing of a pump to control the water.

The El Capitan Mine is supposed to be an extension of the Peregoy and Heiser Mine. The vein courses here 62 degrees east of north, and dips to the east. It is nearly three feet in width. Has a shaft down thirty-seven feet on the vein, with slate walls; the quartz is the same quality of ribbon quartz.

MARIPOSA ESTATE MINES.

This is one of the largest and most favorably appointed mining properties, not only in this State, but in any country. It embraces an area of forty-four thousand three hundred and eighty-seven acres, extending in a southeasterly and northwesterly direction a distance of fifteen miles, with an averege width of five miles. The whole tract is found to be intersected by a network of veins, but very few of which have been opened up to the present time. The region in which the estate lies was noted in an early day for the extent and richness of its placer mines, which still yield good returns when worked during the rainy season.

The general course of the veins is from northeast to southwest, extending through the property in its greatest length. The most extensive explorations have been made on the Princeton, situated near the center of the estate, and which has been traced for three miles and a quarter, and the Josephine and Pine Tree, situated in the northern extremity, near the Merced River, and which seem to be prongs of the same vein.

These are all situated on the great Mother Lode, which runs through the estate for a distance of ten miles, and the latter veins crop out boldly on the sides of Mount Bullion, which forms a part of the eastern boundary of the property. Some other veins, as the Mariposa and the New Britain, situated near the county seat, Mariposa, and others, have been opened to some extent.

Bear Creek, Agua Fria Creek, and Mariposa Creek run for a great part of their length through the estate, having small towns of the same names situated on them. Mount Bullion and the country lying to the east are granitic, while the sole of Bear Valley and the west foothills are old clays and talcose slates.

The Princeton has a record of yielding $3,000,000 from workings down to five hundred feet in depth. Its ores and general features are very similar to those of the Mother Lode as seen in Amador County mines. The latest work has been performed on the Josephine Mine, which forms the crest of Mount Bullion. It is situated two miles north of the town of Bear Valley, thirty-five miles east from the railroad at Merced; freighting to which costs the company one half cent per pound. The cost of freight per railroad from San Francisco to Merced is $10 per ton.

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MENDOCINO COUNTY.

By ALEX. MCGREGOR, Assistant in the Field.

This county derives its name from Cape Mendocino. The cape derives its name from the famous navigator, Jaun Brodriguez Cabrillo, who discovered it in 1652, and named it in honor of the illustrious Senor Antonio de Mendoza, the Viceroy of Mexico.

Mendocino County has never attained any reputation as a mining county; there is, however, considerable mineral within its limits; both lode and placer deposits have been found, but none of them have been worked to a successful result. This county derives its principal revenue from the lumber, wool, hops, and tanbark interests.

TOPOGRAPHY.

The county, from the north to the extreme southern limit, is eighty-four miles in length, and its extreme width, from east to west, is sixty miles; it has an area of three thousand eight hundred and sixteen square miles. The Eel River country comprises forty-nine, the Russian River seventeen, and the Coast Range thirty-two townships. All the valleys in the county are rich in arable lands, and are known as follows: Round, Eden, Little Lake, Sherwood, Long, Potter, Walker, Anderson, Sanel, and Ukiah Valleys.

The principal rivers are Eel and Russian. Eel River has its source in the center of the county and along the line of Lake, Colusa, and Tehama Counties. Russian River heads in Potter and Walker Valleys, and follows southerly through Mendocino to Sonoma County.

Farming land comprises one hundred and fifty thousand acres; grazing land comprises one million acres; redwood land comprises eight hundred and fifty thousand acres; waste land comprises four hundred and forty-two thousand two hundred and forty acres; making a total of three thousand eight hundred and sixteen square miles, or two million four hundred and forty-two thousand two hundred and forty acres.

The watercourses, other than Eel and Russian Rivers, are Gualalla River, Garcia River, Navarro River, Albion River, Little River, Big River, South Eel River, Noyo River, Ten-Mile River, Elk Creek, Greenwood Creek, Salmon Creek, Casper Creek, Pudding Creek, Wages Creek, Cataneva Creek, and Usal Creek. All head in the redwood belt and run west to the Pacific Ocean. There is a sawmill located on each of these watercourses. Each mill owns and controls a shipping port.

SOIL.

The soil of Mendocino County is of three classes, viz.: argillaceous, adobe, and loam; all three contain more or less sand. The first is found on the mountain sides, and is not considered very prolific. Adobe

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On the following day I crossed a ridge which forms the northwestern prolongation of the Sanhedrim Mountain, descended into Eden Valley, then crossed one more high ridge and descended to the Middle Fork of Eel River. On reaching this stream I left the road, and traveling two or three miles farther down the cañon reached the locality of the "coal bed," having traveled that day about twenty and one half miles.

It is difficult to give any very clear idea of the topography of this region without an accurate map. The whole country, however, is very mountainous. From the mouth of the Blue Lakes Cañon to the mouth of Cold Creek on the East Fork of the Russian River the road skirts the northern base of a high unbroken ridge known as Cow Mountain. The axis of Cow Mountain bears considerably more to the west of north than the general axis of the mountains between Clear Lake and the Russian River; and to the south and southeast of Cow Mountain there appears to be a tendency to a similar direction of the mountain ridges all the way as far southeast as the Geysers.

We did not ascend the Cow Mountain, but as seen from various high points it appears to be in all probability a little higher than Uncle Sam.

From the mouth of Cold Creek up the cañon to the foot of Potter's Valley is two or three miles. This little valley appears to be about six or seven miles long, in a northwesterly direction, with a maximum width of two or three miles. The soil appears to be good, but the land is held at prices which, so far as I could learn, far exceed its actual value for any purpose for which it can be employed.

From the head of Potter's Valley to the South Eel River the country traversed by the trail is a high mountainous mass, unbroken by any deep cañons until we decend to the river bed at the southwest base of the Sanhedrim Mountain.

There is, therefore, an error in the map which represents the little valley here known as Scott's Valley as draining to the eastward through this region into Eel River. The trail which I followed passes to the east of Scott's Valley, and there is no depression in the mountains here which even approximates the depth that would be required to permit Scott's Valley to drain in this direction, and it is also my impression that all the gulches here descend in directions to the west of the meridian.

It may also be noted that the maps and notes of the land surveys, though very incomplete, show Scott's Valley to drain to the southwest towards Little Lake Valley.

The cañon of the South Fork of Eel River is very deep, and immediately northeast of it rises the Sanhedrim Mountain, its crest being, I think, not less than three thousand feet above the cañon of the river at its base.

The form of this mountain appears to be that of a long ridge running northwesterly and southeasterly, and the higher portions of its crest do not appear to vary greatly in height for several miles. Beyond its main crest, however, it is still continued far to the northwest in the form of a great massive ridge between Eden Valley and the South Eel River, and stretching towards the lower portion of the Middle Fork.

The road crosses this ridge just west of the termination of the main crest of the mountain. The distance by a good but constantly ascending grade from the South Eel River to the summit of this ridge is about seven miles, and the descent, still steeper, on the opposite side into the head of Eden Valley is about three

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quantity of lime in the rocks also appears to diminish. White solid quartz occurs far more frequently. Even the granular metamorphic sandstones have a different look.

At one point near Upper Lake I noticed even the entirely unaltered sandstone so filled with scales of mica as to render its structure thoroughly schistose. Indeed, appearances everywhere are such as to suggest at once the question whether on going northwest from Clear Lake, among the higher mountains, there is not a gradual and more or less complete change in the general lithological character of the rocks, from that which is peculiar to the Coast Range farther southeast, to one which is more similar to that of the rocks in the western slope of the Sierra.

It will be interesting to note whether this suspicion shall be verified or not by further explorations in this direction. I wish, however, to be understood as applying these remarks at present only to the higher mountains which constitute the crest and central mass of the range, and not to its eastern flanks, where, as in the vicinity of Little Indian Valley and the North Fork of Cache Creek, I saw far less of a tendency in this direction.

Of the western part of the range between our line of travel and the coast, I could, of course, see nothing.

It would be exceedingly interesting to know, if possible, what has been the cause of so great and strikingly marked a difference as that which exists between the general lithological character of the metamorphic rocks of so great a portion of the Coast Range, and that of the metamorphic rocks of the Sierra. The simple fact that these rocks are of different ages is no adequate answer to such a question. It lies deeper. Is this great difference due to original differences in the character of the sedimentary beds from which these rocks were formed, and if so, what were those differences? Or was it due to peculiarities in the character and *modus operandi*, and, perhaps, also in the duration of the metamorphic action itself; and if so, what were those peculiarities, and how have they contributed to produce so vast an ultimate difference of results?

It will be noticed from what precedes that on this trip to the Eel River coal bed I saw no rocks in place of any kind whatever excepting metamorphic ones from Lakeport to the Middle Fork of Eel River; but on reaching the crossing of this stream, and leaving the road and traveling down the river bed, I had proceeded but a few hundred feet before I met unaltered sandstones striking north 50 degrees west magnetic, and standing vertical. Some of these sandstones are very heavy-bedded, and they are much disturbed. About a quarter of a mile farther down the river, sandstones, shales, and pebbly conglomerates strike about north 20 degrees east, and dip 80 to 85 degrees southeast.

A few hundred feet farther on, the strike on the north side of the river is about north 50 degrees east, and the dip at a high angle to the northwest; while nearly opposite, on the south side of the stream, the strike is north 30 degrees west, and the dip is about 70 degrees northeast.

Half a mile farther on, the strike is north 50 degrees west, and the dip 35 to 40 degrees northeast. Perhaps a quarter of a mile farther on, the strike is northwesterly on both sides of the river, but on the south side the dip is southwesterly; while immediately on the opposite side,

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in the prolongation of the same strike, the dip is northeasterly, some 40 to 50 degrees in each case.

Just below here a broad belt of metamorphic rocks, consisting of jaspery shales, serpentine, etc., crosses the river in a northwesterly direction, and extends westerly down the river to within a few hundred feet of the coal bed. Then follows a belt of unaltered fragile shales, etc., which incloses the coal.

Salt Creek is a little stream which heads near the point at which the Round Valley road crosses the summit of the ridge between Eden Valley and the Middle Fork, and running first southwesterly for two or three miles, then makes a sharp bend to the north and runs in this direction for nearly a mile, entering the Middle Fork at a point just above the outcrop of the coal, and close to the section corner between Sections 1 and 2, 11 and 12, T. 21 N., R. 13 W., M. D. M.

Just below the mouth of Salt Creek occurs the coal bed which is described in the Seventh Annual Report, pages 149 and 190.

Nearly opposite the mouth of Salt Creek and about a quarter of a mile to the north from the river, there projects from the mountain side a heavy mass of metamorphic sandstone terminating with a sharp pinnacle at the top, which is probably six or eight hundred feet above the river; this peak is a prominent land mark, and is known as the "Big Rock."

The line of strike of the coal in the river bed passes just to the west of the Big Rock, which latter appears to belong to the metamorphic belt noticed in the river bed just east of the coal.

In company with Mr. Hunter I climbed the ridge on the north of the Middle Fork, and between it and Round Valley. On the way we passed a section corner between Sections 1 and 2, T. 21 N., and Sections 35 and 36, T. 22 N., R. 13 W., and we reached the crest of the ridge at a point in the northwest quarter of Section 36, T. 22 N., R. 13 W.

The rocks in this region are generally poorly exposed, but all the bowlders upon the crest in this vicinity are unaltered sandstone.

From here we traveled westerly along the crest of the ridge to a point on the southeast quarter of Section 27, and not far from the corner between Sections 26 and 27, and 34 and 35 in the same township. At this point the rocks are metamorphic, and there is some serpentine. Big Rock bears from here south 37 degrees east magnetic. From here I observed that to the west of Round Valley, and between it and the Eel River, there rises an irregular ridge considerably higher than our standpoint, and whose eastern flanks, at least, consist to a considerable extent of unaltered rocks.

From here we traveled perhaps half a mile farther west, to a point at which Mr. Hunter thinks that the coal bed seen at the mouth of Salt Creek crosses the crest of this ridge. This point is on the eastern side of a broad, though not very low gap which runs across the mountains here, separating the crest of this ridge from the one which lies on the west of Round Valley. From here the mouth of Salt Creek bears south 46 degrees east magnetic, and the rocks at this point are metamorphic. Mr. Hunter stated, however, that in the gap a little farther west there are sandstones, and added the fact, which I afterwards observed myself, that from the vicinity of this gap there stretches southeasterly towards the mouth of Salt Creek and obliquely down the southern slope of the

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ridge we are now on, a long and heavy bluff of unaltered sandstone which has a northeasterly dip.

From the middle of this gap the general course of the cañon to Round Valley is about north 40 degrees east magnetic, and on the northwestern side of this cañon, at a point bearing north 21 degrees west, about one and a half miles from our standpoint, there commences a bluff of unaltered sandstone, which runs from thence apparently almost unbroken for at least one and one half miles, or perhaps two miles, northwesterly before it disappears over the crest of a large mountain spur. The strike of the rock which forms these bluffs, as nearly as can be judged from here, is about north 20 degrees west magnetic, and its dip about 23 degrees northeast. The locality now in question, it will be observed, is in the eastern flanks of the mountains west and southwest of Round Valley.

At a point bearing north 17 degrees west magnetic, and distant some two and a half miles from our standpoint, and immediately overlying the sandstone bluff just noticed, is a locality where coal is said to have been found, and at another point bearing north magnetic from here, and about two miles distant, is a place which is said to have been the first one at which coal was discovered in this country. This last point I afterwards visited, because, though Mr. Hunter informed me that sufficient work had never been done at either of these spots to expose any coal in place, yet I afterwards heard from another source that $300 worth of coal had been extracted and sold from the latter point. And I may as well state here the results of this visit, though it was made in connection with a trip into Round Valley on the following day. All that I saw there was some little irregular streaks, one of which was perhaps a foot in thickness, of coaly matter; but most of it was very soft and shaly, though some of it was bright and looked pretty pure. The strike in the vicinity seemed to be northwesterly, and the dip northeasterly.

But this locality has never been dug into more than five or six feet, not enough to expose any solid rock of any kind in place, though such rock is probably very near the surface. The debris of this coal is scattered along the gulch for one or two hundred feet. But the rock in the immediate vicinity, so far as I saw, appears to be all of it more or less metamorphic, and there are chalcedonic quartz and jasper close at hand, though the exposures are very poor. I next walked three or four hundred yards farther up the hill, and looked as carefully as my time would permit along the little gulches, but I saw no more indications of coal. I visited this spot alone, yet I think there can be no doubt about my having found the right place, for the topography, etc., corresponded with the directions given. But I certainly saw nothing even approximately workable in the way of coal, and any statement that $300 worth of coal had been taken from that locality is simply absurd.

This completes the account of the coal which I saw in this region. There are, however, several other points which I did not visit at which coal is said to have been found, and which may be upon the same bed which crosses the river at the mouth of Salt Creek.

The following information relative to these points was obtained from Mr. Hunter, who states that at a point about three quarters of a mile southeast from the river, loose pieces of coal have been found on the hillside, but that no coal has yet been seen there in place. Also, that north

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morphic country may also be of the same age, and what metamorphic agencies could have altered this belt so entirely, while leaving belts immediately adjacent so completely intact?

A visit was made to Round Valley. The little village here is situated on Section 1, T. 22 N., R. 13 W., near the middle of the east side of the section. The longer axis of this valley appears to be some seven or eight miles long, in a direction about north 40 degrees west magnetic, and the shorter axis at right angles to it some five or six miles in length; a strip one or two miles in width along the southwest side of the valley is more or less gravelly and is not timbered, and the soil is rather poor. The rest of the valley, however, is covered generally with a rich loam, well timbered with oak. A considerable portion of it is subject to overflow at times in the winter and spring. The chief and almost the exclusive business of the settlers is stock raising.

The mountains around here are generally well watered, and afford good summer range for cattle as well as sheep.

On my return from Eel River, I followed the stage road all the way from the Middle Fork to Potter's Valley, but saw only metamorphic rocks. From Potter's Valley, however, instead of following the road by which I came, I took a trail across the mountains to the head of Bachelor's Valley, expecting to find the party at Upper Lake. Not finding them, however, either here or at Lakeport, I continued on, reaching camp at Kelseyville on Sunday morning.

Along the western slope of the mountains, just southeast of Potter's Valley, I noticed many bowlders of unaltered sandstone, but saw no unaltered rocks in place until I reached the lower part of Bachelor's Valley.

Along the road from Hopland to Ukiah metamorphosed sandstones and clay rocks are the only ones visible, except at one or two localities where some serpentine occurs.

Two localities were visited in the mountains west of the valley, and not far from Ukiah, where some money has been spent in prospecting for coal. The first locality, known as that of the "Miller Boys," is about one mile up a cañon which comes into the western side of the valley at a point about two miles south of Ukiah. The rock here is a blocky metamorphic sandstone, with little irregular seams of coaly matter not over a quarter of an inch thick running here and there in various directions through it. There is also here some soft clay shale, but the stratification is obliterated. It is probably three hundred or four hundred feet above the valley.

The second locality, shown me by Mr. Henry Faulkner, is perfectly similar in its formation and general character to the preceding one, and is in a cañon some four miles northwest from Ukiah. Both are worthless, and it is not likely that coal of any value will ever be found in such rocks as these.

A third locality was also visited in a cañon one and one half or two miles west of Ukiah, where I was informed that what seemed a "lava-like" material occurred. The "lava," however, turned out to be a black metamorphic clay shale filled with slickensides, and the country generally to be a counterpart of that at the two "coal prospects" above described.

The so called "Vichy Springs" are located in the Russian River Valley about three miles east of Ukiah, but were not visited.

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MERCED COUNTY.

By W. L. WATTS, Assistant in the Field.

A glance at a map of Merced County, with its numerous creeks and rivers, would at once classify it among the best watered counties in California, but there is something about the appearance of these streams, with their tortuous course so clearly marked, especially upon the western side of the county, that strikes one as anomalous; for although swelling to good sized rivers near their source, instead of acting as tributaries to the principal river of the county, toward which they flow, they diminish in their course, and finally waste away in the sandy portions of the more central part of the valley. Indeed, through a great period of the year three fourths of the channel of many of them is filled with arid sand, although close to the foothills a good sized stream may still be found.

It is to such phenomena that we must look for the explanation of the flowing wells we are about to consider, and have so frequently drawn attention to in other pages of this report; although, doubtless, most of the artesian water of Merced County, especially in the deeper strata of the valley, is of more distant origin, and commences its subterranean journey where the phenomenon of sinking streams is developed on a larger scale.

The character of the rocks forming the hills upon the eastern and western side of the county has produced a marked effect upon the distribution of the waters of the streams which, from archaic to modern times, have been employed in tearing down the rocky formations through which they pass, and distributing their disintegrated constituents over the valley below, or over the floor of the lake or estuary which probably occupied it in earlier geological periods.

Thus, many of the rocks at the headwaters of the Chowchilla River are granitic, and so are the foothills through which that river flows. The sands brought down by the shifting waters of that stream all contain much mica, and it is in these sands that the Chowchilla sinks beneath the blue clay which overlies the water-bearing strata we are about to consider; although during periods of prolonged rain a large volume of water is emptied by the Chowchilla into the San Joaquin River.

It has been observed by well borers that in a line west from the Chowchilla watershed the first few water-bearing strata struck in the valley yield a most bountiful supply.

The foothills through which Bear Creek flows are largely of a slate formation, and the sand brought down by the waters of this stream contains much less mica than is the case with the sand brought down by the Chowchilla River; and a much greater proportion of its waters flow into the San Joaquin, a running stream extending to the main river through a much longer period of the year.

It has been observed by well borers, that in a line west from the watershed of Bear Creek the first few water-bearing strata struck in the valley do not yield as an abundant supply as those immediately to the west of the Chowchilla. Similar phenomena have been observed in areas subtending the watersheds of other streams, whose physical relations to the rocks amongst which they flow, and the sands they form, correspond respectively to those of the streams above referred to.

ARTESIAN WELLS.

The artesian area within which flowing wells have been obtained extends throughout the county from a southeasterly to a northwesterly direction upon either side of the San Joaquin River. This area may, roughly speaking, be said to be bounded upon the northeast by the main line of the Central Pacific Railroad, and upon the southwest by a line about one mile northeast of the San Joaquin and Kings River Canal.

The strata from which flowing water is obtained are found beneath a stratum of blue clay, which is struck at a depth of from one to two hundred feet upon the eastern side of the area described, and from two to three hundred upon the western side. Upon the western side of the valley this stratum of blue clay does not appear to rise; indeed, as has been already observed, it lies much deeper than upon the eastern side of the San Joaquin River.

The shallowest flowing wells are upon the eastern edge of the artesian area, but they yield the least amount of water; as the center of the valley is approached a greater depth has to be attained, but the flows are stronger.

The strong flow of artesian water continues upon the west side of the San Joaquin River to within two miles of its western limit; at that point the hydrostatic pressure which afforded strong flowing wells nearer to the San Joaquin, owing to the rise in the surface of the ground, is only able to yield a weaker flow. The identity of the water-bearing strata is evidenced by the fact that when receding westward from the point of strongest flow, the relative strength of the flow from borings of similar depth is inversely proportional to the superficial elevation.

Toward the eastern limit of this artesian area, flowing water can be obtained at a depth of one hundred and twenty-eight feet, but in no great volume, the water only just flowing over the edge of the casing at the surface of the ground.

The following is a typical vertical section showing the strata penetrated when boring between the eastern limit of the artesian area and a distance of about eight miles in an easterly direction from the San Joaquin River:

Character of Strata.	Thickness, in feet.
Soil, usually sandy loam	3 to 10
Grayish clay interstratified with sand	90
Surface water is usually struck at a depth of twelve to fifteen feet beneath the surface; it is fair potable water, but somewhat hard.	
Blue clay	35
Sand with flowing water	1 to 15
Blue clay	10 to 20
Sand yielding another flow of water	1 to 15
Clay generally blue, sometimes gray	10 to 20
Sand yielding another flow of water	1 to 15
Gray clay	10 to 50
Sand usually containing a flow of water	1 to 15
Reddish clay and sometimes gravel (this stratum is sometimes absent)	1 to 15

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Below this depth alternate strata of sand and reddish clay have been observed, both containing much mica.

Very few deeper borings appear to have been made within this portion of the artesian area, or, if made, the Field Assistant of the Bureau could obtain no reliable records concerning them.

Between the San Joaquin River and a distance of eight miles from its eastern bank, the superficial strata are said to contain more "alkali," which contaminates the water for the first twenty-five feet, and sometimes until the clay is struck at a depth of about two hundred feet.

The following is a typical sketch of the formations penetrated by boring between the eastern bank of the San Joaquin and a distance of about eight miles east of that river:

Description of Strata.	Thickness, in feet.
Surface soil	9 to 15
Grayish clay, interstratified with sand	200
Blue clay	40 to 70
Sand, with flowing water	1 to 20
Several eight-inch wells were mentioned to the Field Assistant, which were supplied from this stratum, and flowed from four and a half to eight inches above casing.	
Blue clay	10 to 25
Sand, with flowing water	1 to 20
Blue clay	10 to 20
Sand, with flowing water	1 to 20
Reddish clay	10 to 30
Sand, with flowing water	1 to 20
Irregular strata of sand and clay, the sand always containing a little flowing water	300 to 400
Blue clay	20 to 30
Sand, with flowing water	1 to 20

Below this, alternate strata of blue clay and sand have been penetrated to a depth of seven hundred feet. Every stratum of sand yielded a flow of artesian water.

Crossing the San Joaquin the strata resembles those already observed, but experience would seem to indicate that the first stratum of blue clay is from fifty to one hundred feet deeper than upon the eastern side of the river, and that it is twenty feet thicker.

Three streams of water are usually relied on below the first blue clay, and they are generally stronger upon the western than upon the eastern side of the San Joaquin.

An artesian well was bored at Los Baños for the Central Pacific Railroad. The following is a record of the strata penetrated:

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County dips to the west, at a grade of somewhere between five and ten feet to the mile. It is the opinion of well borers that the principal grade is to the east of the San Joaquin River.

SHALLOW WELLS.

Around the city of Merced, the surface water is struck at a depth of eleven to twelve feet, but most of the wells are from thirty to ninety feet deep, from which depth a good supply of potable water is obtained.

The superficial strata around Merced City present great lack of uniformity for the first sixty feet, but after that depth are of more uniform occurrence.

Typical sections of strata penetrated around Merced City show:

Character of Strata.	Depth of Strata, in feet.
Soil	3 to 8
Hardpan	1 to 3
Sandy clay	7 to 14
Sand and gravel (with water)	2
Red clay	30 to 40
Sand and gravel (with good supply of water)	2 to 5
Bluish unctuous clay	20 to 25
Fine bluish quicksand	2 to 3
Hard red clay	20 to 50
Clear coarse gravel (with good water)	4 to 10

North and east from Merced City, the superficial strata are still more irregular, the strata observed by well borers not exhibiting a sufficient uniformity of sequence to generalize with regard to them; the only defined characteristic of ordinary occurrence being a stratum of cobblestones from two to fifty feet in thickness, which is usually encountered somewhere between the surface and a depth of one hundred and ten feet.

As the eastern foothills are approached, the water appears to run in veins, occasionally showing small springs upon the surface of the ground which last throughout the year. In one instance, nearly two hundred feet had to be bored before a supply of water could be obtained. Close to the foothills the cobblestones increase in size.

Toward the Merced River, northwest from Merced City, the strata becomes more sandy and more uniform, being almost composed of sand until a stratum of bowlders is encountered at a depth of eighty to one hundred feet, in which a good supply of potable water is usually found. It is said that a well was sunk on the Weaver Ranch, near Livingston, to a depth of about twenty-five feet; after digging through five feet of sand and about twenty feet of grayish blue clay, the workmen broke through into a stream of running water, which filled the hole. Throughout the district traversed by the lower portion of the Chowchilla River, the superficial formations are principally sand, and, although an unusually abundant supply of water can be obtained at an inconsiderable depth, much inconvenience is experienced from quicksand.

In a westerly and southwesterly direction from Merced City, it is good boring through alternate strata of sand and clay; there are no cobblestones nor bowlders. The surface water is usually struck at a depth of nine to twelve feet, and an abundant supply of potable water is obtained at thirty feet. This will hold good for several miles to the west of the San

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The Crocker & Huffman Land and Water Company.—This company take their water from the Merced River, at a point three miles above Snelling, the old county seat of Merced County. They are about to repair the dam that was injured by the freshet during the winter of 1889 and 1890. They have about twenty-one miles of main canal already built, which discharges into the Yosemite Lake. This lake is used as a distributing reservoir, and it covers an area of about one square mile. When the dam is repaired, this company will divert about two thousand cubic feet of water per second, where the main canal leaves the dam. Lateral ditches extend to the west and south from the canal, between the dam and the Yosemite Lake. It is also proposed to extend a network of irrigation ditches below the Yosemite reservoir; also, to the south and west. This company are irrigating about sixteen square miles of territory; they contemplate extending their system through an area comprising three hundred and six sections.

The Stevenson & Mitchel Canal Company.—This company take their water from the San Joaquin River in Sec. 6, T. 9 S., R. 12 E., M. D. M. No dam is necessary, because the level of the river during a great portion of the year is higher than the level of the surrounding country. The canal runs in a northwesterly direction for about twenty miles, irrigating about fifty thousand acres of land. The canal, where it leaves the river, diverts about five hundred cubic feet of water per second.

The San Joaquin and Kings River Canal.—This irrigating system, which irrigates upward of thirty thousand acres in Merced and adjoining counties, has been in operation since 1872, it being incorporated under the name of San Joaquin and Kings River Canal in September, 1871. It takes its water from the San Joaquin, near the mouth of Fresno Slough, in Fresno County. Probably about twenty sections have been irrigated by this system in Merced County during the last season.

As might be supposed, irrigation produces a marked effect on the depth of the water plane, not only throughout the districts irrigated, but also throughout the territory by which such districts are subtended. Thus, the irrigation of land by the San Joaquin and Kings River Canal has changed the depth at which the surface water can be found between the canal and the San Joaquin River. For instance, on the land of J. Lasen, seven miles west of the San Joaquin, near the east bank of the canal, about five miles south of Newman, before the construction of the canal the formation penetrated in boring a well, and the first two water-bearing strata were as follows:

Character of Strata.	Depth of Strata, in feet.
Sandy sediment	34
Surface water.	
Stratum of reddish clay	24
Gravel, containing a good supply of potable water.	

Since the canal has been constructed, the surface water is struck at a depth of twelve to fifteen feet.

Also, upon the Page Ranch, it was observed that when water was flowing in the canal, good water could be found passing beneath the soil in the direction of the San Joaquin River, above the hardpan, at a depth of three to four feet. When water was not flowing in the canal, an

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INFLAMMABLE GAS.

Inflammable gas has been struck in several wells a few miles southwest of Merced City at a depth of about six hundred feet, notably upon the Ould's Ranch, which is six miles southwest from the county seat. There, the gas from a well six hundred feet deep is collected in a receiver nine feet high and six feet in diameter, which it fills in twenty-four hours, much of the gas going to waste. The gas is used on this ranch for heating and lighting purposes and gives great satisfaction.

IRON, COPPER, AND COAL.

An iron claim was located by Adolph Zotte about twenty-five miles southwest of Los Baños, in 1888, and a small amount of work was done thereon. He stated that he sent samples of the ore, which is a hematite, to Pittsburg, where he had it assayed, the assay showing 92 per cent of ferric oxide. It was said, however, to contain too much phosphorus for the manufacture of Bessemer steel.

Copper and coal locations have also been made in the same vicinity. Coal croppings are also said to occur in the foothills on the eastern side of the county, between Bear Creek and the Merced River, but no work has been done thereon.

ASBESTOS.

Asbestos of good fiber is said to occur near the Mariposa County line, in T. 7 and 8 S., R. 16 E., M. D. M.

GYPSUM.

I was informed of a deposit of gypsum on the Los Baños Creek, in T. 10 and 11 S., R. 10 E., M. D. M. Also heard of gypsum cropping out at several points along the eastern slope of the Coast Range in this county, but was compelled to reserve its investigation for another season.

In view of the fact that there are large areas of land around Lake Tulare and throughout the valley of the San Joaquin River, which are said to require large quantities of gypsum as manure, the occurrence of an extensive deposit of that mineral in this locality might be particularly advantageous.

POTTERY CLAY.

Pottery clay and porcelainite are said to occur near Merced Falls, in T. 15 E., R. 14 S., M. D. M., on the property of T. W. Minges and L. J. Ivett, on the south bank of the Merced River.

BRICK CLAY.

Bricks are manufactured by C. A. H. Warfield, of Merced City. His yards are situated on the southeast bank of Bear Creek, within a mile of the center of the city. At that place, a stratum of clayey loam is exposed, four or five feet in thickness. Experience has proved it to be of the correct composition for the production of brick, without any admixture of sand or other materials. Bricks manufactured from this material have been generally used in Merced City for the last eight or ten years, and appear to be wearing well. They are all hand-made and burned in open field kilns.

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MODOC COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

The same topographical and geological features that mark Lassen County are continued through Modoc County. A succession of valleys, that at no distant day were inland lakes, follow one another clear through the county from north to south, retaining in the northern valleys remnants of some of these large bodies of water, more notably Goose Lake, Tule Lake, and the three lakes of Surprise Valley. These valleys are connected by narrow rocky cañons, or are separated merely by low volcanic ridges, and are bordered by uniform bluffs of volcanic rock, marking the limits of the former lava-flows. These immense outpourings of lava can be traced to Lassen Butte for a source in the southern part of the county, and the peaks in the Warner Range for the northern flows, with perhaps some little from Mount Shasta to the west.

Warner's Range, which divides the Goose Lake country from the Surprise Valley section, attains in several places a height of over eight thousand feet. The names of the seven most prominent peaks are Mount Bidwell, Castle Rocks, Mount Delano, Mount Saddleback, Mount Drummond, Mount Sargent, and Cole's Peak. Of these, Mount Saddleback is seven thousand four hundred and forty feet, and Mount Bidwell, eight thousand six hundred feet high. This range is a branch of the Sierra Nevada Mountains where it breaks down from the main divide north of Susanville, and taking a northeasterly course, passes above Eagle Lake, through the Madelaine Plains, and thence turning north, passes up through Modoc County to Oregon.

Comparatively a large area of the county is utterly worthless as far as agriculture is concerned; another large portion can only be utilized as range for stock, and although there is undoubtedly mineral in the county, yet on account of the lava covering, explorations are so difficult that no mining of any consequence is being done. The county depends largely on stock raising, the hillsides furnishing a very nutritious native grass that cures on the stalk, and furnishes a supply of winter food for outside stock. Pitt River, one of the main sources of the Upper Sacramento River, takes its rise in this county, and, with its tributaries, supplies the county fairly well with water. It starts from some large springs a short distance below the south end of Goose Lake. An old settler informed the writer that, when he first settled in the valley, Pitt River had its source immediately out of Goose Lake. The river drains all of the county west of Warner's Range.

In leaving Lassen County, traveling north, the road, shortly after crossing the county line, passes through the town of Adin, situated on Ash Creek, a tributary of Pitt River, before reaching which, however, it spreads over a wide swamp.

Leaving Adin to go to the north, the road passes through a narrow connection which unites Round Valley with Big Valley. Round Valley,

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deriving its name from its shape, has a diameter of about eight miles; it is a fruitful valley largely devoted to grain raising, surrounded by eruptive hills; from it the road leads through a narrow cañon on its northeast side and over a divide five thousand five hundred feet high; then turns west into Stone Coal Valley. Through this cañon Rush Creek has forced its way in basaltic lava, and running through the valley unites with Ash Creek before they enter united into Big Valley. On the divide, after gaining the highest point (five thousand five hundred feet) near which some altered sandstones may be seen exposed surrounded by eruptive rocks, the road turns to the west into the long, narrow Stone Coal Valley. At Mr. Sherer's house, within whose property the best exposures of the shales and lignites that give this valley its name may be seen along the banks of the creek of the same name; the aneroid showed an altitude of four thousand five hundred and seventy-five feet. Stone Coal Valley is twelve miles from Adin, and is four miles long by one mile wide. The coal strata have a strike of 65 degrees west of north, and dip about 25 degrees north. The valley is surrounded by low-lying, well-timbered hills, covered with yellow pine, cedar, and bull pine.

Beyond Pitt River, which flows close by, at a distance of fourteen miles, are the noted lava beds, in which, during the Modoc war, a handful of Indians, through their intimate knowledge of the same, were able to defy the United States troops under General Canby. These beds are seamed and fissured in a bewildering manner, and contain, beneath the surface, large cavities where, in the process of the lava cooling, the top cooled first, and later the interior found some vent and ran out. In some of these underground cavities supplies of water may be found, enabling those acquainted with the ground to support life where otherwise all appears dry and barren. By crossing the Pitt River bridge close by, and following up the river for about one mile, evidences are seen of a former damming of the river by lava, through which the stream has ultimately forced its way, leaving lava cliffs on both sides nearly three hundred feet high. The river at this point at present is about twenty-five feet wide and about two feet deep, with but little current. The bed of the valley is composed of shales, sandstones, and lignites, capped around the edge by the basaltic lava-flow. Ten miles east of Stone Coal the main road enters Hot Springs Valley, which is twenty-five miles long and four miles wide, and similar in every way to the former valley. It derives its name from some large hot springs, one of which may be observed close to the road to Alturas, on the south side. The water, which shows to be several degrees above the boiling point, issues in the center of a pool with considerable force, and runs down in quite a stream into the valley, where it is used for irrigating purposes. Between this valley and the South Fork Valley the road crosses some low ridges of sedimentary rocks that run down into the bottom. Alturas, the county seat, is at the junction of the three valleys—Goose Lake, South Fork, and Hot Springs—on the banks of Pitt River.

Following the road along the river, we have an extended view of the Warner Range, with its commanding peaks sloping down into the valley, while close along the banks of the river we find cones of a very recent sandstone. The valley proper is quaternary, bounded by the volcanic table lands. South of Alturas about three miles, tuff as well as sandstones are quarried, and used to a limited extent for building pur-

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purposes in summer. A considerable body of water is accumulated behind it.

Four different craters were noted on the mountain, and the amount of scoria, ash, and slag testified to their former activity. At the south side evidence of the ever present prospector was found, in some holes that had been sunk, and some small piles of copper-stained quartz stacked up alongside. Parties in Bidwell had some specimens of rich float gold quartz that they stated had been found on the main range, but no veins have been found; indeed, as far as the writer could find out, there are no mines in the county. A few miles below Fort Bidwell a road takes over the mountain range to the west, reaching, in a few miles, Fandango Valley. The same mass of eruptive rocks is seen here as in crossing Cedarville Pass. This divide has an altitude of six thousand four hundred and thirty feet, according to aneroid reading. From the divide to Goose Lake is a distance of ten miles. The road strikes the lake near Willow Ranch, a place not far from the State line. The northern part of this lake belongs to Oregon. From Willow Ranch to Davis Creek, at the southern end, the road flanks the lake all the way, and shows no change in the nature of the rocks. The lake is about forty-five miles long and eight miles wide. The opposite side from the road is a rocky, barren shore, with low-lying timber-covered hills, and but few settlements in sight. The depth of water in the lake is about twenty feet, and the same has a brackish taste. At the south end Davis Creek empties into the lake.

There is undoubtedly a mineral belt passing through this county, starting from near Adin; thence to Happy Camp, and through by Dry Creek into Oregon. At Happy Camp some prospecting has been done and some little encouragement met with, but up to the present nothing that could aspire to the name of a mine has been developed.

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reason to believe it will before many more years have passed away, inasmuch as these lessons of adversity have not been without their uses.

One of the fruitful causes of disaster to Bodie was the manner in which the principal owners, after realizing large revenues from the mines, scenting reverses ahead, managed to dispose of their shares while they were yet at a premium, and, pocketing the proceeds, left the country to its fate.

As a rule, the shares so disposed of fell into the hands of working miners, and other persons of small means, who, being residents of Bodie and naturally confiding in the future of the mines, invested freely in these worthless "securities," to their general undoing.

But these and similar experiences, though damaging to the individual, and for the time being hurtful all around, are likely to prove beneficial to the mining industry in this section of country, all who have had anything to do with the business having become thoroughly impressed with the necessity of observing greater economy, care, and system in its conduct hereafter.

It is the case, too, that while the most of the exploratory work done here has proved disappointing, it has not been altogether barren of useful results, such considerable bodies of low grade ores having been developed in some of these mines as to encourage the hope that they can be worked with profit, recent improvements and economies in handling them being availed of.

With a view of testing this problem, Mr. Arthur Macy, Superintendent of the Standard Company, commenced last summer concentrating the ore then being extracted from that mine, two Frue vanners having been procured for the purpose. After a short trial, so satisfactory were the results that three additional machines were ordered, with the aid of which enough concentrates have since been turned out to keep the company's twenty-stamp mill profitably employed a good portion of the time, the experiments, as a whole, being considered a success. At last accounts the Bodie Tunnel Company was considering the expediency of adopting a similar method in handling their ore, of which they have on hand a large stock of like low grade. In this new departure the miners and millmen of Bodie profess to see a partial, if not entire, lifting of the clouds that have so long lowered over their town and district.

Prior to this attempt at ore concentration, works had been put up with a view to testing the feasibility of treating the tailings of the Noonday Mill by leaching. This trial, though conducted on a limited scale, the works erected having a capacity of only five tons per day, turned out so well that Mr. Moore, the experimenter, afterwards commenced putting up works having a daily capacity of forty tons, a quantity that may be considered small in view of the immense amount of this material here available. The process as here carried on is both simple and inexpensive.

By this process these mill tailings are stated to be washed up to 98 per cent of their assay value, which varies from $7 to $8 per ton, the resultant metallic product being half gold and half silver. Mr. Moore pays the Noonday Company 50 cents per ton for their tailings. As the cost of treating them amounts to but $3 50 per ton, there is left a fair margin of profit. Should it come to be general, this rehandling of the tailings that have accumulated in vast quantities below these Bodie mills will

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give employment to a large number of men, and thus further increase the business of the camp.

While the handling of these low grade ores and other neglected products must result in such manifest advantage to the miners and residents of Bodie, it does not follow but what other valuable bodies of ore will yet be found in these mines, those best qualified to judge of the prospect believing that such will be the case.

That so much costly exploration would not have been kept up here throughout so many years without a reasonable chance of success, may fairly be inferred; what strengthens this view being the fact that this work is still, to some extent, continued, nor is it likely to soon cease altogether.

With little exception the mining industry throughout the whole of Mono County has, during the period mentioned, experienced nearly as great depression as at this more central locality, the neighborhood of Benton included.

THE BLIND SPRING, MONTGOMERY, WHITE PEAK, INDIAN, AND CLOVER PATCH DISTRICTS.

A good deal of ore has, during the past two years, been taken out, the most of it in the Blind Spring District, and nearly all in small lots.

This ore has, for the most part, been extracted by the owners of the mines or by miners working the claims belonging to others on lease or on tribute. It is invariably of high grade, ranging from $100 to $500 per ton, the average fully $150, this grade being reached by careful assorting.

It consists chiefly of the black sulphurets of silver, or, as the miners here call it, "black metal," and contains almost always more or less antimony, lead, and copper, with a small per cent of iron and zinc and a trace of gold, some of the smaller veins being gold-bearing in their character.

The ledges here occur for the greater part in granite, a few also in limestone, these with occasional intrusions of eruptive rock constituting the prevailing formations of the country.

In these several districts there are now nearly a hundred miners at work, making from $4 to $6 per day to the hand, chloriding. Another hundred or more might make equally good wages here, provided they were men of the right kind.

As this style of operating requires no capital, and is attended with speedy and sure returns, the ore being mostly sold to the smelters, it has become highly popular with the men who practice it, the conditions for its successful prosecution being here exceptionally good.

The ledges throughout these districts are generally narrow and carry their ores in small bunches; the miner, when one of these bunches is worked out, searching for another.

A portion of these ledges has been tolerably well opened, some of them having been thoroughly exploited many years ago. Wagon roads or pack trails have been built leading to a majority of the mines. Wood and water are in fair supply, while the climate is such that work can be carried on to advantage for the greater part of the year. The Carson and Colorado Narrow Gauge Railroad traverses this region centrally, affording good facilities for shipping out the ore, the most of

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which is sent to the Selby Smelting Works. As there are competing works of this kind in the field, the miners here usually realize fair prices for their ore.

After making trial of the smelters at Denver, Omaha, and elsewhere, they have come to the conclusion that they can dispose of their ore to the Selby Company to better advantage than to any other. Hence the most of it goes by rail to the works of that company, near San Francisco. This ore, after being assorted in the careful manner here practiced, runs all the way from $75 to $500 per ton, the average being at least $150. Ore that will not net the miner $75 per ton is left on the dumps. The cost of transportation by rail to the Selby Smelting Works ranges from $8 per ton for the poorest class to $15 per ton for the richer.

Some of the ore is sold to the small mills in the neighborhood or sent to them for treatment. Under the circumstances the miners in this section of country are not so anxious now for local reduction works as they once were, the advent of the railroad having made them measurably independent of both mills and smelters.

This growing indifference to the presence of these establishments accounts, at least in part, for the many idle reduction works to be seen along the mineral belt lying adjacent to the railroad and reaching one hundred and fifty miles to the south, conditions similar to those about Benton having there come to largely obtain. Twelve years ago three smelters were erected at Darwin, Inyo County, that number having at the time been considered essential to the prosperity of the town and surrounding district. After running for a few years these works were all permanently shut down. Of these costly structures two remain, the other having been demolished, and although they are in a fair state of preservation, it has not been thought worth while to expend upon the survivors the comparatively small amount of money that would suffice to restore them to usefulness.

The miners in the vicinity of Darwin send the most of their ores to smelters abroad, subject to wagon transportation twenty-four miles to Keeler, the nearest station on the railroad, showing how little use they have, or think they have, for establishments of this kind nearer home. The proprietors of these smelters at Darwin having found after several years' trial that they could not afford to pay the miners remunerative prices for their ores, owing to the many disadvantages under which they were obliged to operate their works, very properly closed them down.

That this state of affairs will prove permanent is not at all probable. Ultimately the railroads will carry in fuel and other supplies at prices so low that ore reduction throughout all this region will become practicable, the great obstacle to this now being a lack of cheap fuel. There is also a chance of a good coal being found in that country, which, should it occur, would still more effectually supply this great local want. What is here said about this region of country to the south will apply in great measure also to the southeastern section of Mono County, though the latter has greatly the advantage over the districts along the Inyo Range, as regards wood, water, and transportation.

In the group of districts under consideration, there have some twenty-five or thirty different claims been worked during the past year, the most of them, as intimated, in a small way. The value of the ore extracted, nearly all silver, amounted to a total of $125,000. This,

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though more than the average annual output of late years, is less than the early product of these districts, which, since 1862, when work was first commenced there, have turned out bullion, ore shipments included, to the value of four and a quarter million dollars.

That their output will for an indefinite period hereafter undergo steady increase may be counted upon with much certainty. The plan of concentrating the low grade ores, of which there are considerable quantities on the mine dumps, when it comes to be carried out, as it promises soon to be, will add materially to the resources of the county. Already enough experimenting has been done in this direction to prove that ore concentration on a large scale can be practiced with satisfactory results. As the highly sulphuretted ores, of which there is a good deal here, will necessarily have to be dealt with in this way, recourse to concentration cannot much longer be delayed.

A number of enterprises designed to facilitate ore extraction and transportation to the railroad have been projected by the citizens of these districts. One of these projects involves the driving of a long tunnel into Spring Hill Mountain, known to contain numerous rich silver-bearing veins, and long the site of many successful mining operations. If built, this tunnel will penetrate the mountain at a great depth, and may ultimately be carried through it from side to side, a thing that would seem to be feasible, as it certainly would be justified in a business point of view.

Some very important prospecting work was begun last year, and is still in progress, in the Indian Queen Mine, situated on the westerly slope of the White Mountains.

This mine, after a prolonged and successful career, dropped out of line a few years ago as a bullion producer, a long and expensive tunnel, run in the expectation of developing pay ore in the deep, having failed of its purpose.

The exploratory work so inaugurated on this property promises to restore it to its former good standing, some valuable ore deposits having already been opened up in entirely new ground. This mine, though situated just over the line in the State of Nevada, comes here properly under notice, it being indebted for its new lease of life to Messrs. Cox and Milner, experienced miners and residents of Benton, with which town the Indian Queen has always had close business relations.

Returning to the westerly half of the county we find that comparatively little has there been accomplished of late.

LAKE MINING DISTRICT.

This district, so named because of a number of small lakes situated within its borders, lies on the easterly slope of the Sierra Nevada at an altitude of nine thousand feet, its westerly limit reaching nearly to the crest of the range. It has, therefore, a rigorous winter climate, the snowfall seriously interfering with winter operations. This is frequently spoken of and better known abroad as the Mammoth District, a name given it from the so called Mammoth lode, and the mill of the Mammoth Mining Company, which occupy a central position in the district. The principal camps here are Pine City and Mammoth City, which contained at one time over fifteen hundred inhabitants; they contain now

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hardly more than a score, all told, this falling off in the population denoting the general decadence that has fallen upon the entire district.

The finding here, about twelve years ago, of a little rich ore in some workings on the Mammoth ledge led to the formation and subsequent incorporation of the Mammoth Mining Company, which, having started a number of tunnels for the development of their mine, built in the summer of 1878 a twenty-stamp mill, the capacity of which was doubled the following year. These tunnels, four of which were started and driven an aggregate distance of four thousand feet, failing to develop any large bodies of high grade ore, that first discovered having meantime been exhausted, this company in the winter of 1881 closed down their mill and suspended operations, whereupon the district was incontinently and almost wholly deserted. Since that time this big mill, originally a very superior and costly structure, there being no one to look after it, has gone to decay. The houses and outbuildings erected by the company for the accommodation of their workmen have been crushed into shapeless ruins by the weight of the snow, while portions of the tunnels driven to open up their lode have caved in, rendering them difficult and in some places impossible of access. It is calculated that this company expended here not less than $400,000, the value of the bullion taken out by them having amounted to about one half that sum; their signal failure illustrating the folly of putting up costly mills or other reduction works in advance of adequate ore development.

For the last three years this mine has been under lease, and thus afforded the owners a trifling revenue.

On the Headlight and Monte Cristo Claims, situated on the same vein, but to the south of the Mammoth, a considerable amount of work has been done, though they have not yielded any bullion.

On the Lisbon Mine, lying still farther south, a five-stamp mill was put up in the summer of 1885, and has since been running successfully on ore from that mine, which has been opened by a tunnel several hundred feet in length. This mill stands about three hundred feet below the mouth of the tunnel, with which it is connected by a tramway. It is driven by steam, wood being plentiful in the vicinity, and runs on a free gold-bearing ore that is said to yield an average of $20 per ton. Several arrastras are being run in the neighborhood on ore of a similar character.

The bullion obtained from these auriferous veins is of rather low grade, the gold being somewhat alloyed with silver. It is better, however, than that from the mines on the Mammoth lode, the value of which averaged only about $12 per ounce.

During the bonanza era at Bodie the Mammoth Company set on foot negotiations for the sale of their mill to parties over there. That they would have succeeded in making such disposition of this property is probable, had not the Bodie mines themselves suffered such disastrous collapse soon after. Though badly demoralized, there is not much doubt but this mill will yet be repaired and successfully run on the site it now occupies. It is, in fact, the opinion of some expert miners who have visited Lake District and examined the condition of things there, that this mill never ought to have been shut down, and that under a proper management it could even now be started up and run with profit. They do not hesitate to declare that in their judgment the Mammoth Company

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seven feet high, with one track already laid down. A large stream of water flows from it at present.

The lodes belonging to this company are generally large, being from ten feet to fifteen feet wide on the surface and carrying, for the most part, heavy croppings. These mines, though not thoroughly proved, are, as a whole, considered very valuable, and now that active operations have been resumed, the probabilities are that determinate results will soon be reached. About $350,000 have to date been expended by this company, $64,000 of this having gone for the construction of a wagon road leading in from the Tuolumne County side of the Sierra, the western half of this district extending into that county.

PLACER MINING.

Located at the northwest angle of Mono Lake, and back some five or six miles from its shore, are the old placer diggings, extensively and profitably worked from about 1857 to 1861, when, being pretty well exhausted, they were abandoned, the miners leaving and going over to Aurora, the objective point of a great rush, consequent on the discovery of supposed rich silver mines in that neighborhood.

So complete was this abandonment that every building in Monoville, the principal town in those old diggings, was, in the summer of 1861, torn down and removed to this new center of attraction. That the placers here were not wholly depleted was believed at the time, this having later on been proved by the return of some of the former residents, who, resuming work, managed for several years to make good wages washing the auriferous gravel with rockers, the only implements ever used here.

The deposits at this place occurred in the midst of enormous granite bowlders, few of which with the appliances then at hand could be moved from their original positions. This being the case, there is reason to believe that a great deal of gold still remains in the diggings. Being covered by the great bowlders, it cannot, however, be gotten out except by the process of hydraulic washing, for the practice of which there are good facilities here.

Water under any desired head and in any quantity could easily be introduced, there being ample fall below the mines to insure effectual riddance of tailings. Under the circumstances this has long been looked upon by the early stock of miners as a favorable site for the inauguration of a hydraulic enterprise. As yet, however, no movement has been made to that end, though gravel washing by this method has been carried on at several other points in the vicinity.

These enterprises, undertaken some ten or twelve years ago, have gradually been suspended, not because they failed to prove profitable, but chiefly because their originators, being largely interested in mining schemes elsewhere, had not enough time at their disposal to look after them properly.

During the past year or two a new set of men have come in who are giving these deposits their attention, some of the old companies also showing a disposition to renew operations, which they now propose to conduct on a much larger scale than ever before.

Last summer, after a thorough reconnaissance of the ground, these

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several parties each matured one or more schemes looking to future operations in this line of mining.

In one instance as much as three thousand eight hundred and forty acres of auriferous gravel land were taken up and recorded, some of it being located as vacant mining land, but the most secured by purchase from former locators. It is expected that these companies will commence active operations as early in the spring as they can get to work, the past season having been too far advanced for this before preliminary measures could be perfected.

Auriferous ravines and gravel beds extend along the easterly base of the Sierra from the Big Meadows, twelve miles north of old Monoville, south to the headwaters of Owens River, a distance of nearly eighty miles. While some of these beds lie at the foot of the mountains, others are situated far up toward their summit, fully four thousand feet above the subjacent valleys on the east. These lower-lying gravel beds have been the sites of the hydraulic operations heretofore carried on, the ravines having been worked by the sluice and rocker, the use of which has never been wholly abandoned here.

Every summer for nearly thirty years washing with these implements has been practiced on the creeks and gulches along this entire eighty-mile stretch.

And thus it is, our mining fields, temporarily abandoned, are coming to be permanently reoccupied, for not again will they be vacated until they shall have been made to surrender all of value that science, skill, and human ingenuity can wrest from them.

As regards the other mining districts in this county that remain to be noticed, so little has been accomplished there during the period under review, that all that need be said of them can be embraced in a few brief paragraphs. In the Patterson District, lying farthest north, work on the tunnel being run by the Monte Cristo Company has been steadily pushed ahead, this work being designed to open up the company's group of claims to a considerable depth. On the other locations in the district, little more than assessment work has been done.

Of the mining population here, amounting to about forty men, a third have been employed on wages; the balance, working on their own account, have been taking out small lots of ore, a portion of which has been shipped away, the remainder being worked at mills in the neighborhood.

The few miners residing in the Jordan, Keith, Hildreth, and Prescott Districts have contented themselves doing the amount of work required by law to hold their claims, and with extracting some small quantities of ore, the most of which has been worked in arrastras built for the purpose.

ALTITUDES AND DISTANCES IN MONO COUNTY.

The figures affixed to the following places denote their elevations in feet above tide water: Benton, 5,510; Mammoth City, 8,500; Bodie, 7,923; Bridgeport, the county seat, 6,439; Mono Lake, 6,756; Adobe Meadows, 6,572.

The following figures show the distances expressed in miles between the places mentioned: Bodie to the town of Hawthorn, 40, northeast; Bodie to Bridgeport, 20, northwest; Bodie to Benton, 55, southeast; Bodie to Mammoth City, 55, south-southwest; Bodie to Mono Lake, 12, southwest.

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MONTEREY COUNTY.

By Myron Angel, Assistant in the Field.

The topographical features of this county are its coast lines and the Gabilan and Mount Diablo Ranges upon its eastern border; the valley of the Salinas River which threads its entire length, and the broad and precipitous mountains which fill its western half.

The eastern mountains rise to an elevation of from two thousand to three thousand feet, with many quite large and fertile valleys. In Peach Tree Valley, near the San Benito County line, are the Warm Sulphur Springs, having a temperature of from 70 to 80 degrees.

In the Cholame Valley the existence of bitumen and maltha created some excitement. Companies were formed and wells bored in search of oil. Some of them were sunk to a depth of six hundred to seven hundred feet, but no flow has yet been obtained. Eastward by the Polonio Pass, in the Mount Diablo Range, this valley empties into the Tulare, and south and westward, by Cholame Creek and Estrella River, opens to the Salinas.

The most important division of the county is the Salinas Valley. From the southern line the valley is narrow and irregular; at the distance of twelve miles it widens out to fifteen miles in its lower part. The average rainfall is about fourteen inches.

The Salinas River has its source in the Santa Lucia Mountains and runs northwest for about one hundred and twenty miles. The bed of the river is sand, in which the water sinks in summer.

Westward from the Salinas Valley and south from the city of Monterey, the country presents a series of hills and mountain ranges almost inaccessible, which have a width of fifteen to twenty miles. This mountain is commonly called the Santa Lucia. This is not exactly correct, although the mountain range appears continuous. In the northern part the Carmelo makes a long valley, centrally the Arroyo Seco cuts through to the east, and in the southern part the San Antonio and Nacimiento separate what there appears as two distinct chains.

In Whitney's Geological Report these are classified as two chains: the Santa Lucia on the west, and on the east the Point Pinos, or San Antonio Range. The Santa Lucia rises direct from the ocean from Point Lopez and Point Gorda south to the limit of the county, with ocean bluffs three or four hundred feet in height and peaks seven thousand feet above the sea. These mountains have not been fully explored, but the Los Burros Mines, in the southwest, show they contain minerals of value.

Besides the mines of Los Burros, gold has been mined from placers on the San Antonio and also on the Big Sandy, a creek in the Mount Diablo Range, near Slack's Cañon. The existence of minerals in great variety is known in the county and fine building stone, also sand suitable for glass melting.

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All the matter extracted appears to be similar in character to that which forms the Gabilan Mountains. The gravel brought to the surface consists of small waterworn pebbles, from a half to two or three inches in diameter, many of the coarser pieces requiring to be broken in the well.

Slight flows of gas were developed at eighty-five, one hundred and twenty, four hundred and ninety-seven, and seven hundred and sixty-four feet deep, but not in sufficient volume to satisfy the projectors.

The fact of gas being found in the gravel beneath the clay leads them to believe that it exists in large quantities beneath some impervious stratum of rock which can be reached by the drill. Others maintain the gas to be a light hydro-carbon or marsh gas, produced from buried vegetation, as well as from other organic matter deposited with the sands before any metamorphism occurred, and which has not, through lack of intense metamorphism, been converted into the heavier hydro-carbon gases.

The projectors of the well are hopeful that their anticipations of obtaining a large supply of gas at no great distance will be gratified. The depth and character of the strata passed and to be passed through will aid in proving the underlying strata of the valley and the relation they bear to the surrounding mountains.

Numerous other wells have been sunk in the Salinas Valley during the past ten years, but none so deep as the one before mentioned. They have all shown the valley to have the same character of formations.

Some flowing water has been obtained at a depth of one hundred and twenty feet; in other wells water was obtained but did not flow. In some of those in which gas was struck, adjoining ones a few yards distant would show no gas, though greater depth was reached.

In 1880 a well was bored in Castroville to a depth of one hundred and seventy-eight feet, producing a volume of fresh water which at high tide flowed in large quantity over the casing, and at low tide ceased flowing. This well is near the mouth of Salinas River, and the surface of the ground is twenty feet above the river.

A well on Mr. B. Marks' land, six miles south of Salinas City, was sunk to the depth of one hundred and fifty-four feet, the last four feet being in bituminous shale, in the boring of which there was encountered water with traces of oil and gas.

THE CARMEL LAND AND COAL COMPANY.

Since the issuing of the 1888 report, the following improvements have been made at the company's property, as reported by Mr. A. Bassett, Superintendent:

Have cleaned out and retimbered seven hundred and twenty feet of tunnel, in which is a two-foot vein of coal. At one hundred feet from the mouth of tunnel there has been sunk an incline, at an angle of 45 degrees, to the depth of ninety-five feet, the vein of coal averaging four feet in thickness. From the bottom of the incline a drift has been run north for a distance of one hundred feet. The coal in this drift averages six feet in thickness, with six to eight inches of fire clay, with slate backing for hanging wall, the foot wall being a very hard slate. At two hundred feet south of tunnel, there has also been sunk a two-compartment perpendicular shaft to the depth of two hundred and seventy-

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NAPA COUNTY.

By W. A. Goodyear, Geologist, and Assistant in the Field.

There are many volcanic pebbles mixed with the metamorphic ones scattered through the soil of Napa Valley between St. Helena and Calistoga, and at one point the foot of the mountains on the eastern side of the valley here was found to consist of a gray rock, whose origin may be questionable, though it is probably a highly altered volcanic or volcanic-sedimentary rock.

From the summit of a high spur of the mountains southwest of Napa Valley, which we ascended, the highest summit of Mount St. Helena bears north 39½ degrees west magnetic. All the rocks observed while traveling up this spur were volcanic in origin. But little rock was seen in place, however, till near the summit of the spur. Here are some bedded rocks poorly exposed on the crest, which seem to be consolidated ash, pumice, etc., and nearer the top is a brecciated rock containing angular fragments of various volcanic rocks with pumice, ash, bits of obsidian, etc. The little hill at the base of which are the Calistoga Hot Sulphur Springs, is some seventy-five or eighty feet high, entirely isolated, and looks from here as if it stood nearly in the center of Napa Valley, though it is in reality a little nearer the northeastern side. It is, however, in the main valley and not in a "side valley," as stated on page 87 of the Geological Report, Vol. I. Knight's Valley is in plain sight. It is a little valley very irregular in its outline, and the country between it and the head of Napa Valley is a region of low hills. To the west and southwest of Knight's Valley, the mountains which separate it from Russian River Valley are much higher, though broken through by cañons and the creeks which drain Knight's Valley. On leaving here we crossed over to a second point of observation upon another spur perhaps one fourth of a mile southeast of the first one. This second spur is made up of bedded gray volcanic rock, which strikes about east and west magnetic, and whose dip I estimated about 35 to 45 degrees to the north. From here the long spur we had just left was also seen to consist largely of similar looking rock, a heavy mass of which outcrops at one point on its southern slope, with apparently the same strike and dip noted above. In the same spur there were also seen irregular masses of the brecciated ashy rock, which is whiter in color than the other, while the gray bedded rock looks from here as if it contained some large angular fragments.

The mountains on the northeast of the upper portion of Napa Valley are known for some distance southeast from Mount St. Helena as the Howell Mountains. They are generally a little higher than the mountains southwest of the valley, and have many sharp, conical peaks scattered along their crest. The highest peak in the range is sharp and prominent, and like many of the other ones, very dark colored. It bears north 57 minutes west magnetic from here. Directly in front (as seen from here) of this peak, which stands a mile or two farther back in the

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conical peaks seem rather to consist of the bedded rocks with no signs, as far as I could see, of craters at their summits.

With the exception of what I afterwards saw on our return trip while riding thirty-two miles through constant rain across the range from Beryessa Valley to Napa, this was the only opportunity I had of studying the interesting and complex mass of rocks which appears to form so large a portion of the crest of this range.

Some of these volcanic beds dip at considerable angles in the mountains northeast of Napa, indicating great disturbances since their deposition, and the high dip of the volcanic beds noted in the mountains southwest of Napa Valley is proof of such disturbances there.

Again, the crest of the Howell Mountains for a considerable distance southeast of Mount St. Helena is ragged and very peaky, and the thickness of the mass of horizontal beds that crown them here is very great, while their highest summits must be in the vicinity of three thousand feet above the sea. Mr. Pettee's calculation of a single observation which I afterwards took makes the highest peak nearly three thousand and fifty feet.

If these beds were deposited in water, as their appearance seems to indicate, then these facts, scanty as they are, would point to the probability of a considerable elevation of this range subsequent to the period of volcanic activity.

On leaving Camp No. 1, we made our next camp about three and a half miles beyond Calistoga, on the Clear Lake road, intending the following day to climb Mount St. Helena. We did so accordingly, but the time being too short for Mr. Craven to complete his observations here in one day, we ascended it again the next day. The road from Calistoga to Lower Lake crosses the lowest point of the saddle which connects the southeast foot of Mount St. Helena with the Howell Mountains. The ascent from the head of Napa Valley to the crest of this saddle (at which there is a toll house) is nearly one half the total height of Mount St. Helena above the valley.

From Camp No. 2 to the Toll House, at the crest of this saddle, was about four miles by the road which follows the cañon. The rocks exposed in this cañon were decidedly puzzling to me in appearance and character. I was at first inclined to accept them as chiefly metamorphic and of aqueous origin. Some of them approximate a hornstone in appearance, while some of them appear to be rather coarse grained, light colored, and easily disintegrating sandstones, and are much and very irregularly stained with oxide of iron.

But other varieties were plenty, and undoubted volcanic rocks were close at hand in adjacent spurs; but on the next day I was in serious doubt whether all the rocks in question were not chiefly volcanic-sedimentary, the apparent sandstone itself having been once a mass of volcanic ash.

When, therefore, we again passed over this ridge I watched them as closely as I could, and even now I feel by no means certain of them. Their variety is large, and, whatever their origin, they have, in any case, been nearly all of them very highly and irregularly metamorphosed and decomposed, and no distinct stratification can be made out.

I am inclined to think, however, that the lower portion for a certain distance upward from the foot of the mountains, consists of rocks which, to a considerable extent at least, are non-volcanic-sedimentary in origin,

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and consist of gray trachytic or rhyolitic rock, in which I did not notice any bedding, but which often assumes columnar forms. In fact, the highest peak consists almost entirely of a mass of well formed vertical columns, which are, however, rough, and have their edges more or less rounded by weathering. High, isolated, and broad topped as this volcanic mountain is, yet I could discover no evidence of the former existence of a crater at its summit. Indeed, I think that the formation of the summit speaks against it, and it seems more probable that the mountain was uplifted in the form of a massive eruption.

The sides and summit are covered to a considerable extent with a species of small, three-leaved pine whose cones grow directly out of the bark of the trunk and the larger branches of the tree, and are always curved, the point of the cone bending downwards and inwards towards the branch on which it grows.

The distance from Calistoga by road and trail to the highest peak of the mountain is eleven or twelve miles—not too far for an easy pleasure ride with good animals to the summit and back in a day—and the trip is well worth making for any one who has the time to spare at Calistoga.

The view from the summit is magnificent, and very extensive. It is by far the most extensive view to be obtained from any point in the Coast Range southeast of Clear Lake till we reach Mount Diablo; and, when the air is sufficiently clear, it must, I think, cover almost as great an extent of country as the view from the latter mountain does; indeed, it may be quite.

The view from the Geyser Peak has been highly praised, but the statement that it is "the finest point of view in this part of the State" (see Geology of California, Vol. I, page 93) is a mistake.

The fact is that, though really a fine one, and indeed the finest one within easy striking distance of the springs at the Geysers Hotel, the view from the Geyser Peak is far from equaling that from the summit of Uncle Sam, and bears no sort of comparison whatever with the view from the crest of Mount St. Helena.

The view of the Coast Range from the latter mountain is limited to the northwest and southeast by the same mountains which limit the view from Mount Diablo, that is, the Mount Hamilton group to the southeast, and the mountains about the headwaters of Eel River and Stony Creek to the northwest. In other directions the air was not sufficiently clear upon either day that we climbed the mountain to enable us to see anything like the full extent of the view; but the best illustration we had of it was upon the morning of the second day, when, for awhile, the crest of the Sierra to the northeast was dimly visible. But it is probably true, as stated to us repeatedly by hunters, that when the air is clear the horizon to the west is the far-distant ocean. In the Sierra, Lassen's Peak would certainly be in full view, with the crest of the range for some distance farther northwest, while I think it very likely that Mount Shasta itself might also be seen peeping over the eastern flanks of the Coast Range. An arc of a great circle from Mount St. Helena to Mount Shasta, according to Holt's map, would pass very near our camp on the spur between Wolf Creek and the North Fork of Cache Creek, and then across the eastern flank of a pretty high mountain just north of the North Fork of Cache Creek; and with the exception of this single mountain, there is nothing, I think, on this line which could interfere with the view of Mount Shasta from Mount St. Helena;

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degrees west, and the other north 39 degrees west magnetic, the latter being very probably the Sanhedrim Mountain.

Of the mountains southwest of Napa Valley, three culminating peaks or ridges as seen from Mount St. Helena appear nearly equal in height, the one on the left being, however, a little the highest. As nearly as could be judged with the hand level the highest of these three summits appears to be just about as high as the highest peak of the Howell Mountains, but it may, perhaps, in reality be somewhat higher, as the Howell Mountains are much nearer.

I climbed several hundred feet up the spur just northwest of Camp No. 2, and took from there some half dozen specimens of rocks which are all volcanic, unless it be one dark bluish, heavy, fine-grained rock, which, on weathering, cracks in all directions and breaks into numberless small, angular fragments, and may possibly be of aqueous origin. Another specimen was a cellular, trachytic rock, whose outcrop is rough and irregular, but shows some tendency to columnar forms. Another one was an aggregate of volcanic ash, pumice, and fine-grained fragments of a variety of other volcanic rocks.

On quitting Camp No. 2, we visited again the Hot Springs at Calistoga, and afterwards the Fossil Forest, and made our next camp on the road to the Geysers beyond Knight's Valley. The Hot Sulphur Springs at Calistoga occur chiefly at the southern foot, and scattered over a small area within a few hundred feet of the little metamorphic sandstone hill already noticed.

The volume of water which they discharge, as well as their temperature, is said to vary somewhat at different seasons of the year. At the time of our visit the quantity of water was small. It is said that over an area of an acre and a half of ground here, salt water may be obtained anywhere by sinking or boring a few feet. The water contains a considerable quantity of sulphuretted hydrogen, and is said also to contain salts of iron, lime, and magnesia.

At two of the springs holes have been bored and pipes inserted to the depth, as we were informed, of sixty or seventy feet, and the water in these pipes is considerably hotter below than it is near the surface of the ground. This point was tested by attaching a weight to the thermometer and letting it down the pipe twenty to twenty-five feet, then drawing it rapidly up and reading it as quickly as possible, having also taken the precaution to wrap it with several thicknesses of cloth, in order to diminish as much as possible the rapidity with which it fell on drawing it up.

The following measurements of the temperatures were made at the springs indicated:

First spring, nearest the hotel and furnished with pipe; temperature at depth of twenty-one feet below surface, 185 degrees Fahrenheit.

Second spring, in wash house, shallow, and with no pipe; temperature, 103 degrees Fahrenheit.

Third spring, at the steam baths in the little house near the large ditch, furnished with pipe; maximum temperature at a depth of twenty to twenty-five feet below the surface, from 195 to 200 degrees Fahrenheit.

Fourth spring, at the pump; 113 degrees Fahrenheit.

Fifth spring, in the little round house; 118 degrees Fahrenheit.

Sixth spring, a small one outside and near the round house; 107 degrees Fahrenheit.

The temperature of the water near the surface in the pipes at the first and third springs ranged from 150 to 160 degrees Fahrenheit. These measurements were made on the twelfth of September.

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of a bedded appearance, but it is very indistinct and no regular stratification can be made out. If, as I am inclined to think is the case, they are metamorphic sandstones, etc., then they have been so highly altered as to make it impossible to decide from hand specimens, and difficult to decide anything certainly with such poor exposures, as to what they are, while bowlders of undoubted volcanic rocks are strewn everywhere over the surface and mixed with the soil.

The next day we climbed the crest of a high hill in the ridge between McDonald's and Russian River Valley.

In the bed of the creek near McDonald's house are metamorphic sandstones; similar rocks are exposed in the eastern side of the ridge to the west. The stratification is nearly obliterated, and the strike and dip hard to make out, the exposures being generally poor. Appearances seem to indicate, however, that the general strike was northwest and the angle of dip high. The rocks were not exposed at the crest of the ridge, but are in all probability metamorphic sandstones, etc.

On the road, perhaps a quarter of a mile northeast of McDonald's house, is one good exposure where the degree of metamorphism has not been so high, and the beds of sandstone and shale are seen to strike at one point about north 60 degrees west magnetic, and dip 45 to 50 degrees northeast. The strata are very much disturbed and bent, and at a point one or two hundred feet farther west the strike is south of west, and the dip is only 30 to 35 degrees.

The next camp was in Knight's Valley, on the right bank of Knight's Creek. From here Mr. Craven climbed a hill about a mile to the north of camp and found there metamorphic sandstones, and also serpentine, of which last there is a large body in that vicinity. He saw no volcanic rocks.

On the next day we climbed to a point of observation upon the crest of a high, bare hill southwest of Knight's Valley. Only two or three poor exposures of the rocks in place were seen on the way to this point, but all seem to be metamorphic sandstones, etc., although the strike and dip are not at all apparent. The summit is sandstone, though smooth, and covered with soil.

At the distance of some two miles, in a direction south 27 degrees east magnetic from here, is a hill, perhaps four hundred feet higher than this one, which is smooth-topped and open, with little timber, and had fences on its summit. The hills to the west and northwest between here and the Russian River Valley are generally rather smooth in outline, and good exposures of the rock seem to be rare, though many of the slopes are pretty steep. It is impossible to tell with certainty from any distance what such hills are. But, at all events, a straight line running from the southeast edge of Knight's Valley in a direction about south 25 degrees west across the hills to Santa Rosa Valley, would have upon the southeast side of it hills which are generally sharper and rougher in outline, as well as more generally covered with chaparral, etc., than those on the northwest of it, both in the mass of hills where we now are and also in the spur connecting Sotoyome Peak with the mountains southeast of the Russian River bend; and the sharp, chaparral-covered hills southeast of this line are certainly covered, to a large extent, with volcanic matter in the form of ashes, breccia, etc., while the smoother and barer hills northwest of it, so far as seen, are metamorphic.

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the northern part of this ridge, whose center bears from here about south 85 degrees west magnetic, and which is free from chamisal. This is the only spot so near the summit of the ridge which is free from brush, and the surface has every appearance of being a local lava-flow from the crest of the ridge just northwest of it.

The lower hills bordering Eticuera Creek from its head to Beryessa Valley show nothing which looks volcanic from here.

The western face of the great unaltered ridge upon whose crest we are, seems everywhere to be more or less bluffy, with slopes of from 45 to 60 degrees for one or two hundred feet, and frequently for greater heights below its crest.

Between here and Camp No. 24 the unaltered rocks have a general strike of north 40 degrees west to north 50 degrees west, and a high dip to the northeast.

The next camp was in Beryessa Valley at the house of Mr. Sewell, on Mr. Lawley's ranch, on the left bank of Eticuera Creek near its mouth.

At a point about a mile below the first camp on Eticuera Creek, the road, which is here on the right or west side of the cañon, is cut for a hundred feet or so out of a solid ledge of unaltered sandstones and shales which strike north 40 degrees west, and dip 72 degrees northeast, but resting against the upper edges of this outcrop, which may be twenty-five or thirty feet above the road, and reaching around it to the road at both ends, are similar rocks apparently considerably crushed and broken, though striking nearly in the same general direction, but dipping southwesterly at an angle of some 50 degrees.

The morning was foggy, and the country could not be well seen, but all the rocks seen in place along the road were unaltered.

Beryessa Valley has in general a rich soil and a smooth and nearly level surface, but its head is irregular in outline, branching and somewhat indefinite, with low rolling hills.

The soil is usually a rich loam, and the valley is well timbered with oak.

The next day, after the heavy morning fog had lifted, we started out to climb the Beryessa Peak, but after traveling between one and two miles a mass of low-running heavy clouds advanced rapidly from the southeast and looked so threatening for rain that we turned back, and I went to hunt up the "placer gold locality" owned by Mr. Lawley.

This locality is in a little gulch at the foot of the hills near the right bank of Eticuera Creek, at a point nearly two miles above its mouth, and from half to three quarters of a mile above the upper house on Lawley's Ranch, which is also situated on the left bank of the creek. A little fine gold is said to have been found here. The bed of this gulch consists of gravel, and a large percentage of the bowlders here, as well as many of those in the bed of Eticuera Creek below, consist of a granitoid rock, which varies much in texture from coarse to fine, but seems to be composed chiefly of quartz and hornblende in varying proportions.

There are also, however, among the bowlders red, yellow, and green jasper, white quartz, serpentine rock, granular metamorphic sandstones, a large variety of volcanic rocks, cellular and compact, some of them being porphyritic, hard metamorphic slates, impure limestones, unaltered sandstones and shales, all rounded and waterworn. Some of the lower foothills about here seem to be composed to some extent of similar gravel. I saw no gold.

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their crevices are filled with calcite, generally nearly pure and finely cleavable, though the seams are thin, usually not over half an inch, but sometimes an inch or two in thickness. Some of these seams extend through many consecutive layers and beds both of sandstone and shales.

The variety of the rocks forming the bowlders of Puta Creek is of course very large.

At the farthest point which I reached in the bed of Puta Creek I left its cañon and climbed the mountain sides on the northeast. From here the general course of Puta Creek was seen to be for a number of miles very straight in a direction south 58 degrees or 59 degrees east. From here, also, I observed a sharp, and undoubtedly, I think, a volcanic peak at the distance of some six or eight miles north 86 degrees west magnetic. Another ragged volcanic mass about as high, but a mile or two nearer, bore north 84 degrees west, and a very sharp little cone pretty high among the mountains bore south 80 degrees west some four or five miles. All these were southwest of Puta Creek. On the northeastern side of Puta Creek, a few hundred feet above it, there is a belt of country one or two miles wide which is pretty free from chamisal, and whose surface is not rough, though hilly. It is generally covered with deep, black soil, which cracks and crumbles in the sun, but the growth on it furnishes an extensive range for sheep and cattle, and this belt extends as far as I could see from here northwesterly towards Coyote Valley, and southeasterly nearly to Beryessa Valley. It would not be a bad route for a road if one were needed in this direction through these hills, and there is a trail across there now.

One can probably in the summer follow without difficulty, on horseback, the bed of Puta Creek from Beryessa Valley to Coyote Valley.

About a quarter of a mile westerly from Camp No. 25, a bed of white material which appears to be consolidated volcanic ash, strikes northwesterly and dips northeasterly, crossing Puta Creek obliquely.

The road, after leaving Monticello at the foot of Beryessa Valley, passes via Wooden Valley across the range.

So far as I could observe to-day in the rain, the mountains seem to consist entirely of unaltered or slightly altered strata from the foot of Beryessa Valley westward nearly to Wooden Valley, the general strike being northwesterly. But near Wooden Valley volcanic rocks make their appearance, and the whole crest of the western portion of the range between here and Napa, as far as seen, was entirely covered with a complex series of stratified and metamorphosed volcanic beds.

Some three hundred or four hundred yards southeast of the Napa Insane Asylum, a quarry has been opened, where the rock is a light gray trachytic or rhyolitic porphyry. It is highly crystalline, but is bedded, and sometimes very thinly laminated, the laminæ being often very straight and regular for considerable distances. It is probably a mass of consolidated and metamorphosed volcanic ash beds. But these beds have been greatly disturbed and broken up since their deposition. At one place they lie nearly horizontal, dipping only some 6 or 8 degrees southwesterly; while close at hand the same beds are upturned at all angles, some of them being nearly vertical. The rock also varies much in hardness and facility of quarrying and working. A large quantity of street paving blocks have been gotten out here and laid down in the streets of San Francisco as "basalt blocks"—a fraud, of course.

All the foundation walls of the asylum itself are built of a similar,

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though somewhat harder rock which came from a short distance east of the asylum, and is a very fair building material. The copings on top of the foundation walls are of Folsom granite, as are also some of the steps; but above these copings almost all the trimmings to the top of the building are of artificial sandstone, which is not very strong, and the blocks of which are already much cracked here and there in the lower stories.

I was told that in the mountains a mile or two east of here, there is a locality of genuine black basalt from which some paving blocks have also been shipped. That large quantities of such rock do exist somewhere back in these mountains is proved by the bowlders which have come down the cañons.

A trip was made from Napa City to Yountville, and thence about three miles westerly to what is known as the Mountain View Quicksilver Claim in the mountains about four hundred and fifty feet above the sea.

At the edge of the foothills, on this road going up from Yountville, there is a small quarry of soft yellowish white volcanic ash rock, which has been used to some extent for road coverings. Along the road above here, until within a short distance of the quicksilver claim, the rocks are all volcanic. Farther up they are very little exposed. For some little distance around the claim, however, they are chiefly sandstones, some of which are partly metamorphosed. A very little cinnabar has been found here in a mass of limestone, which may possibly be a vein striking nearly north and south. Immediately adjoining this limestone there is a heavy mass of black and very soft clay shale, which contains some sulphuretted hydrogen. But at the time of my visit sufficient work had not yet been done here to even show whether the limestone was a vein or not.

From here we returned to Yountville, crossed the valley, and drove southeast along the edge of the foothills on its eastern side. Everything along these hills, so far as could be seen or judged, appears to be volcanic. At one point a quarry was visited where a large amount of work was done many years ago, the material consisting of consolidated white and yellow, and often mottled, volcanic ash, which is said to have been carved into some kind of vases. But the work did not pay, and was long since abandoned. This mass of ash deposit is immediately overlaid by a very heavy body of rather coarse-grained, hard, and dark-colored porphyry, which appears to be solid and in place.

After following the edge of the hills a few miles farther southeast and seeing no rocks except volcanic ones, we turned easterly and went up to the Napa Soda Springs, which are situated a couple of miles or so back in the mountains east of the valley, nearly north from Napa City and seven hundred feet above it. The rocks exposed all along the road leading up to the springs are exclusively volcanic, though there is considerable variety of texture, amongst which there are large quantities of breccias and conglomerates. Most of the buildings at the springs are constructed of a rather soft, yellowish and bluish white volcanic ash rock which was quarried close at hand.

About two miles northwest from Calistoga, at the edge of the foothills on the west side of the valley, and close to the Geyser road, a material occurs which has been called "callustro," and is used in the manufacture of a variety of soaps and polishes. It is essentially a clay, containing some free silica, the particles of which are generally impalpably fine.

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It has resulted from the decomposition of a rather dark gray metamorphosed volcanic ash rock which was rendered slightly pophyritic by the presence of very small white particles sparsely scattered through it. This rock is generally laminated, sometimes very thinly so, and then shattered and broken up by innumerable cross seams, so that it now comes out in small irregular angular blocks.

The original rock was both hard and tough, but the decomposed material, of which the "callustro" preparations are made, is generally quite soft, and either white or light gray in color. When powdered it is snow-white. It is first dried and pulverized by a Smith & Behm's Universal Pulverizer (a centrifugal machine), and then separated by a pneumatic winnowing apparatus into grades of different fineness. The finest of these grades contains its free silica in so impalpably, or almost chemically fine a condition, as not to injure its polishing properties; for while it will polish silver very quickly and easily, it does not perceptibly scratch it.

About half a mile north of here is another locality of similar material, where a mill was being built, and where the quantity seems to be practically inexhaustible.

All the rocks seen in this vicinity are volcanic. There is a great deal of consolidated volcanic ash rock, and in places considerable quantities of obsidian are scattered in small fragments over the surface. No signs of craters were seen.

At the Grigsby & Johnson Silver Mine, in the foothills of the Howell Mountains, northeast from Calistoga, and about one quarter of a mile southeast of the road from there to Lower Lake, the country rock inclosing the mine is a porphyritic felsite, some of which is more or less decomposed and soft, although much of it is yet very hard and tough. This rock is overlaid by heavy masses of light yellowish volcanic ash rock; but still higher up in the mountains the precipices are nearly black, and in places show columnar forms. The vein strikes about north and south magnetic. During the last two years a good deal of stoping has been done, and the ten-stamp mill has been kept constantly running, the average yield of ore, as stated by Mr. Grigsby, being about $25 per ton in silver, and the bullion always running above nine hundred and twenty-five fine.

The old Silverado Mine is located on the southeastern slope of Mount St. Helena, less than a quarter of a mile westerly from the Toll House at the summit of the road. The inclosing rock here seems to have been originally a volcanic ash, or a rather fine breccia, which has, however, been greatly metamorphosed, and afterwards very extensively and irregularly decomposed, some of it being soft, while much of it is very hard and tough. The vein here strikes about north and south magnetic, and dips about 73 degrees to the west. It varies in thickness from six feet or less to twelve or fifteen feet. It was worked to a considerable extent from 1873 to 1875, and it is said that during that time two thousand three hundred tons of ore yielded $93,000. But from some cause or other work was stopped here in 1875, and the mine has lain idle ever since. But now (May 31, 1890), Mr. Daniel Patten has just set a few men at work to reopen it and work it further.

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NEVADA COUNTY.

By J. B. HOBSON, E.M., Assistant in the Field.

This county, which is located in the north central portion of California, derives its name from the Sierra Nevada Mountains, which traverse the eastern boundary.

In contour it is long and narrow—about seventy-five miles in length and from seventy-five to twenty miles in width.

The reason of this is owing to the South Yuba and Bear Rivers on the south and the Middle Yuba River on the north being its natural boundaries.

It is bounded on the north by Yuba and Sierra Counties, on the south by Placer County, on the east by the State of Nevada, and on the west by Yuba County.

The county covers a superficial area of about nine hundred and seventy-five square miles, and in its geographical features is remarkably developed, reaching from the lower benches of the mountain foothills six hundred feet above sea level to the summit of the Sierra, an elevation of eight thousand feet. The general course of the river boundaries is from northeast to southwest, and through the northern central portion it is partly divided by the South Yuba River, which unites with the Middle Yuba near the western boundary of the county and forms the main river, which is a tributary of the Feather River. The western and middle portions of the county present a pleasing variety of landscapes in wooded hills, small valleys, or rolling uplands, a large part of which is well adapted to agriculture and grazing, and to the cultivation of orchards and vineyards. Along the extreme western boundary citrus fruits grow to perfection, as do the olive and other sub-tropical fruits, while through the central portion, in which are located Nevada City and Grass Valley, at an altitude of two thousand five hundred feet, the Bartlett pear and other fruits of the temperate zone reach their best development in flavor, while at an altitude of three thousand five hundred feet, and four hundred feet farther up the mountain slopes, the apple attains a superiority unequaled by similar fruit raised at lower elevations. The variety in soil, the difference in temperature and accessibility of transportation, are encouragements to fruit and vineyard culture that is making a valuable and profitable production, steadily growing into importance, and which will in the near future prove a source of considerable local wealth.

The western section of the county, without being heavily timbered, is well provided in that respect, the principal growth being white and black oak, yellow and nut pine, manzanita, and chamisal. The central portion has a more extensive growth of pine, which has been largely used for timbering purposes, and the original growth, which has been cut off, has been succeeded by dense forests of pines growing upon the ferruginous soil, which is a proof of its strength and fertility.

In the same sections the black oak abounds on the ridges and in the

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which there are different varieties, and earths and clays suitable for pottery, but yet undeveloped or made the means of industrial product.

SOIL.

The soil of Nevada County, in its analysis, is similar to that of Placer County, and with proper cultivation is capable of producing cereals and fruits without the aid of irrigation. Wherever irrigation has been used crops of every character have been raised in remarkable abundance.

CLIMATE.

So much has been written in praise of the climate of California, that anything said on the subject is necessarily a repetition; but it is a fruitful theme, and it is difficult to exhaust words in commendation of a climate which makes this State favored above the others of the Union. Whatever appertains in this respect to other portions of the State applies equally to Nevada County. The climate is in all respects healthful and salubrious. Its elevation above the low lands of the Sacramento Valley lifts it above malarial influences, and its middle and mountain sections are inviting to those seeking health and recreation. The temperature is comparatively mild at all seasons, although from the extremes of elevations (from six hundred to eight thousand feet above sea level) there are marked differences at the same season of the year. In the summer when the days are hot in the foothills, in the mountains the atmosphere is tempered to agreeable moderation, while the nights, at even the lowest altitudes, are always comfortably cool.

There are but a few days in the year when the thermometer marks above 83 degrees Fahrenheit, and in winter it is seldom that the temperature goes below the freezing point in the middle section of the county; but in the Truckee Basin, which is east of the Sierra, it falls below zero for several days in the season, and makes it practicable to harvest ice in large quantities, which, as an article of traffic, finds an extensive market in all parts of the State.

The summer season is dry. Occasionally showers fall in the early part of June, but during the remainder of that month and through the months of July, August, and September rain seldom falls, and usually in October the showers are but light.

The remaining months of the year comprise what is known as the rainy or winter season. In the lower foothills snow is rarely seen; and in the middle section attains but a moderate depth. It does not remain long on the ground, owing to its moist and unfrozen condition.

In the higher mountains snow falls to considerable depth, covering the summit ranges, and remains late into the following summer months, and on the northern side of the higher peaks snow may be seen at all seasons of the year. It is the variety of climate, difference of elevation in the country, and the picturesqueness of the landscapes presented, that makes Nevada County particularly inviting as a home or attractive to the tourist, who always retains a pleasing recollection of a visit to this interesting and beautiful region.

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tract of land on both sides, including a mill site. The course of the vein is east and west with a dip to the south varying from 55 to 73 degrees; its average width is thirty inches; the ore shoot has a pitch to the east at an angle of about 40 degrees.

Since the publication of the Eighth Annual Report, in which mention was made of this mine, the main incline has been sunk a further distance of two hundred feet, encountering a vein of good ore which seems to improve in depth; but enough work has not yet been done to determine whether the ore body that has been encountered is a continuation of the old shoot or the apex of a new one.

The fissure of the Idaho vein occurs in a serpentine formation, whose northern side is overlaid with a narrow filling of talc schist which forms the foot wall. The hanging wall is a hard, fine-grained diorite. The old forty-stamp mill has been entirely reconstructed during the past year. The old amalgamation system with its blanket washing has been abolished and the latest improved system of aprons and silver-plated plates has taken its place. At the same time the old Cornish buddles have given way to sixteen Frue vanners, making the new mill first class in all respects. The workings of the mine have attained a vertical depth of two thousand feet. During the years of 1889 and 1890, thirty-nine thousand two hundred and twenty-five tons of ore, valued at $20 a ton, have been extracted.

Omaha Consolidated Mine.

This mine is situated one and one half miles south of Grass Valley, on Wolf Creek. The property is a consolidation of the Omaha and Lone Jack Mines, having an extent on the lode line of two thousand six hundred feet.

The vein itself is a strong contact vein coursing north and south, with an average westerly dip of 32 degrees. Its average width is over one foot, the vein in places increasing in size to two or three feet.

On the surface that portion of the mine to the south of the Omaha incline was in a syenite formation. As depth was attained, however, the formation changed to a slate, so that at present the entire mine is in a slate formation, insuring easy working and permanency in depth.

The Omaha Mine is worked through two incline shafts, distant from each other about eight hundred feet: the north or Omaha shaft, down over eight hundred feet, and the south or Lone Jack shaft, down seven hundred feet on the incline.

All the lower levels are connected through, thus insuring great accessibility and the most perfect ventilation of any mine in the district. A great deal of development has been done in the last two years, and has been very successful in the results accomplished.

The mine possesses three distinct pay shoots: the first, a discovery of this latter working, lies to the north of the Omaha shaft; the second, the original Omaha shoot, lying between the Omaha and Lone Jack shafts; and the third, or Lone Jack shoot, lying in the lower levels on the south of the Lone Jack shaft.

These shoots all trend rapidly south at an angle of about 40 degrees in the plane of the ledge.

The lower levels are well opened a total distance of over one thousand

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five hundred feet, and the ground stoped for a distance of about nine hundred feet on the levels.

The results of deeper work on the property have been most satisfactory, there having been a steady increase in the size of the vein and the value of the ore as depth is attained.

The ore produced from the tenth, the lowest level stoped, has surpassed in quantity and value that produced from any of the upper ones.

The grade of the ore from the entire mine is very high, averaging from $20 to $30 per ton.

The mine is well equipped with an eighteen-stamp mill, which, however, is shortly to be increased by ten stamps. The weight is eight hundred pounds, dropping seven inches ninety-six times per minute, crushing through forty-mesh brass wire screens. Steel shoes and iron dies are used.

Inside silvered plates five inches in width are used in the battery, and the sulphurets are saved on four improved belt Frue vanners.

Many improvements and additions have been lately made in the plant. Notably the raising of the mill building, allowing the use of rock breakers and ore bins, the ore being fed to the battery in Hendy feeders. A large addition to the hoisting works raises the landing floor, and all ore from both the Omaha and Lone Jack shafts is delivered into the mill building direct by efficient tramways. The resulting plant is very complete, insuring cheap handling and milling of the ore produced.

The mine is well furnished with cheap water power, obtaining water from Wolf Creek under fifty feet of head, to run the pumping and hoisting machinery in the Omaha shaft, and water from the North Star Mine to run the mill and the Lone Jack hoist. This latter water power is conveyed by a ditch from the North Star Mine to a reservoir above the Omaha, thence delivered under a one hundred and forty foot head by a short pipe-line. Pelton wheels are employed throughout—a six-foot wheel for hoisting, an eight-foot to run the pump, and a seven-foot to furnish power for the mill.

All water is pumped through the Omaha shaft, the upper pump being a twelve-inch plunger on a six-foot stroke and running eight strokes to the minute.

A total of one hundred and fifteen men is employed in the mine and the surface plant.

Altitude	2,290 feet.
Length of inclined shafts	700 and 800 feet.
Water raised from mine	12 miner's inches.
Kind of powder used	Hercules No. 2.
Number of stamps	18.
Drop	7 inches.
Number of drops per minute	96.
Feeders used	Hendy Challenge.
Kind of shoes	Chrome steel.
Kind of dies	White iron.
Number and kind of rockbreakers	One; a Blake.
Size of apron plates	4 feet wide by 15 feet long.
Sluice plate	18 inches wide by 12 feet long.
Number of concentrators	4.
Kind of concentrators	Frue improved belt.
Percentage of sulphurets	4 per cent.
Value of sulphurets	$80 to $130.
Treatment of sulphurets	Sold to chlorination works.
Number of men in mine	100.
Number of men in mill	5.
Number of men on outside hoist	8.
Wages paid in mine	$3 per day.
Wages paid in mill	$3 per day.

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Wisconsin Mine.

This mine is situated two and one half miles south of Grass Valley, on the Allison Ranch road, at an altitude of two thousand three hundred and eighty feet.

The property extends thirty-four hundred feet on the lode, the vein coursing northwest and southeast, and dipping to the southwest at an angle of 35 degrees. The quartz vein averages fourteen inches in width, and the ore is high grade, showing coarse gold freely, and carrying high-grade sulphurets. The vein is inclosed in syenite walls.

The underground workings opened during the present operation of the mine consist of an incline shaft, with a length of one hundred and seventy-two feet, attaining a vertical depth of ninety feet. One level is turned at the depth of one hundred and thirty-six feet on the incline, extending north one hundred and thirteen feet, and south one hundred and twenty-five feet. The ore extracted and milled from this level shows an average of $14 per ton in free gold, with sulphurets running $75 to $100 per ton. The shaft is down thirty-six feet below the level, showing a large ledge of very high grade ore.

The vein was formerly worked at a point farther north, the shaft being distant six hundred and fifty feet from the present incline. This shaft, an incline also, had a length of five hundred feet on an inclination of 35 degrees.

Five levels were turned from it, extending north two hundred feet and south a maximum of four hundred feet. This ground was stoped out for a depth of four hundred feet, yielding a continuous product of high grade ore. It is the intention with the present shaft to intercept this north shoot in depth, besides working the two shoots farther to the south, on one of which the present incline is sunk.

Three pay shoots have been opened up so far, with a total length of six hundred feet. All three shoots pitch rapidly south at an angle of 40 to 60 degrees.

The energy of the exhaust steam from the non-condensing steam engine, which is usually entirely lost, is in a very simple and ingenious manner used to ventilate the mine. The steam escaping from the engine discharges through a small nozzle into the air pipe, and carries along by friction the surrounding air particles. In this way a current is induced in the air pipe sufficient to ventilate the mine in a most satisfactory manner.

The principle is the same which is used in the mercury air pump, the steam injector, and the hydraulic elevator, and its successful application to ventilation is due to Mr. Wiltsee, Superintendent of the Wisconsin Mine.

The property is at present equipped with a steam plant; only one and one half cords of wood are used per day, the water being very light. A sixty horse-power horizontal engine runs both pump and hoist.

Work on the mine was inaugurated within the past few months, and has met with great success. It is the intention of the company to immediately erect a twenty-stamp mill and bring in water power with a head of over seven hundred feet, by connecting with the Empire pipe-line on Ophir Hill. Seventeen men are employed underground and on top, the wages paid being $3 per day.

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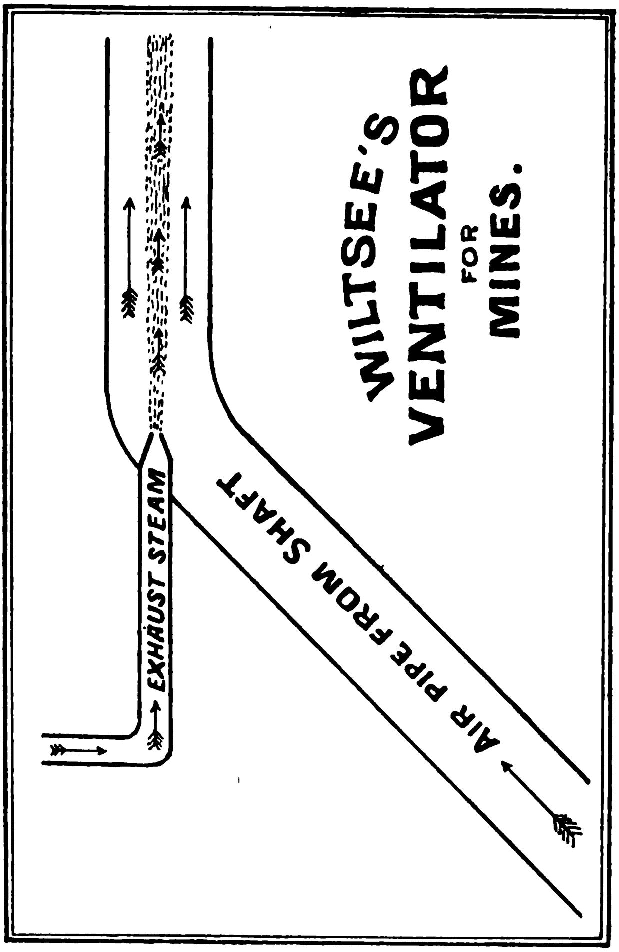

Altitude	2,380 feet.
Length of ore shoots	900 feet.
Length of high-grade pay shoots	600 feet.
Length of present ore shaft on incline	172 feet.
Length of old north ore shaft on incline	500 feet.
Vertical depth reached by present incline	90 feet.
Character of hanging wall	Syenite.
Character of foot wall	Syenite.
Kind of powder used	Safety Nitro No. 2.
Cost of mining	$4 per ton.
Character of ore	Free milling, carrying sulphurets.
Grade of sulphurets	$75 to $100.
Wages paid underground	$3 per day.
Wages paid on surface	$2 50 to $3.
Quantity of wood used for pumping and hoisting	1½ cords per day.

North Star Mine.

This mine is situated two miles south of Grass Valley, at an elevation of two thousand four hundred and seventy feet. The property is three thousand two hundred feet long by eight hundred feet wide. The vein courses east and west, dipping north at an average angle of 20 degrees.

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The claim extends fifteen hundred feet on the lode, coursing southeast and northwest, and dipping southeast with an inclination of 32 degrees.

The vein is inclosed in walls of talc schist, and averages twenty inches in size.

The underground workings consist of an incline shaft on the vein six hundred feet in length and reaching a vertical depth of about three hundred feet. There are three levels turned, at a depth of three hundred and sixty-eight, five hundred and eight, and six hundred feet, respectively. These drifts have a maximum extent north of three hundred feet, and south of four hundred feet.

A drain tunnel one thousand two hundred feet in length, and intersecting the shaft at two hundred and fifty feet on the incline, relieves the mine of the surface water.

The ore is free milling, containing a small percentage of sulphurets. The mine is kept clear of water by a system of three pumps, the largest being an eight-inch plunger, running seven strokes per minute. The mine is operated by steam power, three cords of wood being consumed per day by two engines.

The ore is at present treated in the Larimer Mill, on Wolf Creek, distant one mile north, and leased by the Hartery Company, and is transported to the mill at an expense of 42½ cents per ton. The mill is a ten-stamp mill, run by an overshot waterwheel. The stamps weigh eight hundred and fifty pounds, dropping seven inches one hundred times per minute, and crushing through Nos. 30 and 40 brass wire screens. The apron plates are four feet by four feet, and the sluice three feet wide and fourteen feet long. An inside plate four inches wide is used in the battery. The sulphurets are saved in Hendy pans and sold to chlorination works; the value is about $50 per ton.

Thirty men are employed in the mine, and six men in the mill and on outside work. Wages paid in mine, $2 75 per day; in mill, $3 per day.

Altitude	2,360 feet.
Length of ore shoot	250 feet.
Vertical depth reached in mine	300 feet.
Character of hanging wall	Talc schist.
Character of foot wall	Talc schist.
Kind of powder used	Safety Nitro No. 2.
Kind of timber used	Pine.
Number of stamps	10.
Weight of stamps	850 pounds.
Drop, in inches	7.
Drops per minute	100.
Kind of screens	Brass wire No. 30 and 40.
Percentage of sulphurets	2 per cent.
Value of sulphurets	$50 per ton.
Number of men in mine	30.
Number of men in mill	4.
Number of men on outside work	2.
Total number of men	36.
Wages paid in mine	$2 75 per day.
Wages paid in mill	$3 per day.

W. Y. O. D.

This mine is situated on Ophir Hill, one mile southeast of Grass Valley, and at an altitude of two thousand five hundred and sixty feet.

The claim has an extent of one thousand five hundred feet on the lode line, the vein coursing north and south, and dipping west at an angle of 38 degrees.

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company has met with encouragement in the work already done, and water power will be brought in and a mill erected as soon as possible. The pipe-line will be eight thousand three hundred feet in length, connecting with the Empire line on Ophir Hill, and delivering water power at the mine with a head of over seven hundred feet.

A total of seventeen men is at present employed. The underground wages are $3 per day, and on surface, $2 to $3 per day.

Altitude	2,385 feet.
Length of shaft on incline	385 feet.
Vertical depth attained by shaft	180 feet.
Character of hanging wall	Diabase.
Character of foot wall	Talc schist.
Kind of powder used	Safety Nitro No. 2.
Timber used	Pine and spruce.
Cost of mining	$2 50 to $3 per ton.
Cost of shaft (14x5) per foot	$8 and $9.
Cost of drifts	$4 per foot.
Character of ore	Free milling.
Value of sulphurets	$75 to $100 per ton.
Number of men employed	17.
Wages paid in mine	$3 per day.
Wages paid on outside work	$2 50 per day.
Wood used	2 cords per day.

Ben Franklin Mine.

This mine is situated two and one half miles south of Grass Valley, on the south side of Osborn Hill, at an altitude of two thousand five hundred and fifty feet. It was located in 1852, and its claim covers an area of one thousand five hundred feet in length and four hundred feet in width.

The vein has a northerly and southerly course, and a westerly dip of 36 degrees, and an average width of two feet. The ore shoot pitches towards the south, and has a length of one thousand feet.

The company commenced working in June, 1890, and their work consisted of constructing a hoisting works, and putting up a pump, and enlarging and reconstructing an old incline which is not situated on the Ben Franklin vein properly, but on a spur of the same.

The dimensions of the incline are nine feet by four feet ten inches; its length is at present one hundred and twenty feet. It is expected to strike the main vein at a depth of about two hundred and fifty feet.

Six or seven inches of water coming in are lifted by an eight-inch bucket pump.

A fifty-five horse-power steam engine of three-foot stroke and thirty-inch cylinder, using one cord of wood daily, does both hoisting and pumping. The exhaust steam of the non-condensing steam engine discharges into the air pipe and ventilates the mine by the so reproduced draught.

The ore is free milling, of high grade, and rich in sulphurets.

Ten men, receiving $3 wages daily, are employed in the mine.

Pennsylvania Mine.

This mine is situated one mile southeast of Grass Valley. The claim covers an area of two thousand eight hundred and sixty feet in length and three hundred feet in width.

The vein has a course from northeast to southwest and a southerly dip of 37 degrees, and an average width of one foot and one half.

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The plant has been greatly improved in the last two years by the erection of the new mill and underground hoisting works.

The ore from the shaft is trammed out through the tunnel; one mule and driver do this work, tramming all waste rock, and supplying the mill ore. The track is of steel T-rails throughout, over two thousand feet having been laid.

Altitude	3,200 feet.
Length of ore shoot	350 feet.
Vertical depth from surface reached in tunnel	230 feet.
Vertical depth from surface reached in incline shaft	370 feet.
Formation of hanging wall	Syenite.
Formation of foot wall	Slate.
Average width of vein	3 to 4 feet.
Cost per foot of running tunnel	$4.
Timber used	Spruce.
Kind of powder used	Giant No. 2.
Cost of mining	$2 50 per ton.
Character of ore	Free-milling, containing sulphurets.
Number of stamps	10.
Weight of stamps	1,000 pounds.
Drop of stamps	6 inches.
Number of drops per minute	80.
Duty per stamp in twenty-four hours	2 tons.
Metal used for shoes	Steel.
Metal used for dies	Iron.
Cost of shoes	9 cents per pound.
Cost of dies	4½ cents per pound.
Kind of screens	Diagonal slot No. 8.
Dimension of screens, inside of frame	48 by 12 inches.
Size of apron plates (silvered)	4 feet by 3½ feet.
Sluice-run	16 inches wide, 15 feet long.
Feeders used	Hendy Challenge.
Percentage of free gold saved in battery	50 per cent.
Percentage of free gold saved on plates	50 per cent.
Kind of concentrators	Triumph.
Number of concentrators	4.
Percentage of sulphurets	6 per cent.
Value of sulphurets	$125 to $175 per ton.
Number of men in mine	32.
Number of men in mill	4.
Number of men on outside work	2.
Wages paid in mine	$3 per day.
Wages paid in mill	$3 to $3 50 per day.
Water used for power	89 inches.
Head of water used for power	120 feet and 76 feet.

WASHINGTON DISTRICT.

Eagle Bird Mine.

This mine is situated on the Yuba River, three fourths of a mile west from Maybert, at an elevation of three thousand three hundred and fifty feet. The property comprises three full length claims, having an extent on the lode line of four thousand five hundred feet. It is seven miles northeast from Emigrant Gap Station on the Central Pacific Railroad, and is connected therewith by an excellent wagon road built at an expense of $8,000. Freight from San Francisco is $17 80 per ton.

The course of the vein is north 15 degrees east, dipping easterly at an angle of 65 degrees; the average width is six feet. The foot wall is a talcose schist, while in the hanging wall it is a chlorite schist, acting as a casing between the vein and the real country rock, which is protogene.

The quartz is hard and free milling, containing, in addition to free gold, pyrites, galena, and blende.

The underground workings are extensive. A tunnel on the vein, six hundred and forty feet in length and reaching a vertical depth from reached, several miles distant.* At this place is a most remarkable bec

* On the occasion of a more recent visit to this locality, I found Tertiary fossils on th western side near the cañon, while the Cretaceous forms were found on the scarps on th opposite side.—S. B.

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3 been growing yearly more imperative in consequence of the alarm-
; decrease (more especially in the Transvaal) of free-milling gold,
1 the proportionate increase of refractory ores.

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a stamp mill. The indications are that they will find it a profitable investment.

On the opposite side of Santiago Cañon is an elevation called "Carbonate Hill," which seems to contain much valuable mineral. It is approached from the southwest along Weakly Cañon, and has an elevation of two thousand six hundred feet above sea level. The most valuable mineral of this "hill" is lead carbonate. W. S. Morrow, who has taken up several claims, has made openings which expose the ledge for some three thousand feet, and it is said to run high in silver. The hanging wall is quartzite, and the foot wall is granite. The dip is eastwardly, which I was informed is true of all the gold and silver-bearing rocks of the Santa Ana Range. Many prospectors were in these mountains at the time of my visit, and several claims were being opened. What is known as the Santa Rosa Mining District had been abandoned for some time, but preparations were being arranged to again occupy this ground. The indications for much activity seemed good. It is my opinion that much mineral wealth is stored in these mountains, but a better and more full report can be made later.

There are some oil deposits about seven miles southeast of Fullerton, near the county line. Two wells have been drilled, one of which is four hundred feet deep, and yields about one hundred gallons daily. It is used for fuel in a steam laundry in Santa Ana, and also for running an engine at the Santa Ana Waterworks. The other well is about nine hundred feet deep, and yields something like eight barrels daily of the same quality of oil as obtained in the first mentioned well. So far the oil has not been obtained here below five hundred feet. Four miles distant are the Puente oil wells, fourteen in number, the deepest of which is twelve hundred feet. A pipe-line conducts the oil to the railroad, six miles distant, and it is claimed that about two hundred barrels is the daily yield. As these wells are located in Los Angeles County I did not visit them.

There are three coal mines on the east side of Santiago Creek. One of these, known as the Santa Clara Mine, is about half a mile from the lower end of Silverado Cañon. A tunnel was excavated for a distance of about two hundred feet, when an incline was begun and continued at an angle of 34 degrees for three hundred and sixty-five feet. Hundreds of tons of coal were taken out of this mine, but it was abandoned in 1889, the proprietors believing they had exhausted it. But recently other croppings have been found, I learned, and at the time of my visit there was talk of resuming work. This coal contained many impurities, yet was considered a fair article.

The Black Star Mine has yielded considerable coal, but of rather an inferior quality. It is still being worked, and there is said to be much more that has not been taken out.

What is known as the Harris Mine is a new discovery, and promises an abundant yield. It is located on the side of a small cañon which debouches into the Santiago, and is one thousand one hundred and twenty-five feet above the sea level. An incline is sunk through the vein to the depth of ninety feet, and at an angle of 50 degrees, dipping south, the strike being east and west.

There are two veins, separated by about seven inches of gangue. The coal seams are about five and fourteen inches in thickness, respectively. A fair article of coal is obtained here, which seems to improve in quality

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The mouth of Alisos Creek being impassable owing to the last winter floods, we let our wagon down a steep incline of some two hundred feet by means of ropes. The sandstone strata near the mouth of the cañon dips southwardly toward the ocean. A mile up the creek there is an exposure of the peculiar conglomerate described above. It extends along the base of the mountain, and is washed by the Alisos Creek, but finally dips under the mountain and is covered by several thousand feet of stratified and cavernous sandstone. The indications are that this formation extends over a large area and has been caused by igneous action. Three miles from the ocean, on the left hand side of the cañon, is a fine exposure of gray sandstone showing an anticlinal axis, from which the strata begin to dip north and south. The altitude of the creek bed is one hundred feet at this place.

One mile above this is an exposure of whitish rock on the west side, which extends for two or three miles along the cañon. It contains fish teeth and fish scales and probably other fossils. Fine forms of breccia were obtained here.

Above this is an exposure of cavernous sandstone, worn into cavities, probably by the action of the elements, and is most likely metamorphic. The altitude of the creek bed at this point is three hundred and forty feet. About one mile above this exposure is a deposit of limestone covering some two hundred acres, at an elevation of five hundred feet. The rock is fossiliferous, *liropectens* predominating, some of which have weathered out of the deposit and make good cabinet specimens. According to a statement of Professor Leonhart, who was present at the time of my visit, and who had made an assay of the mineral, it contains 96 per cent of lime, 2½ per cent of silica, 1 per cent aluminum, and one half per cent of iron. Near by is an extensive deposit of blue clay, containing, according to the same authority, 58 per cent silicate, 19 per cent aluminum, and 7 per cent of iron. Uniting the two a fine cement is obtained, which is said to be superior to the famous Portland cement. I am informed that this cement has been subjected to a pressure of four hundred and seventy-five pounds to the cubic inch, while the Portland article admits of but three hundred and fifty pounds to the square inch. A company has been formed to manufacture it on the ground.

El Toro Station is at a bend of Alisos Cañon, nine miles from the ocean. A plain here debouches into the Santa Ana Valley. Not far from the station is a lime kiln, where lime is manufactured from fossil shells, to which I have previously referred in this report. The elevation of El Toro is nearly six hundred feet. Continuing up the cañon in a northerly direction to Alisos school house, one meets with the fossil bones of cetacea imbedded in bowlders. The divide is reached about five miles from El Toro, when the descent into Trabuca Cañon begins. Near the residence of W. L. Robinson is a stratum of carbonaceous shale, overlying sandstone strata, and dipping to the west. The elevation is one thousand three hundred and fifty feet. I discovered another carbonaceous deposit in Weakly Cañon, at about the same elevation.

San Joaquin Bay, which extends up about four miles from the ocean in a northerly direction, has a bluff exposure all along the western side from seventy-five to one hundred and ten feet in height. Half a mile above the New Landing is an outcrop of conglomerate rock, composed

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Michael, of Fairview; H. F. Goff, of Arch Beach, and many others in the county. Every possible facility was afforded me by the citizens of the county in my exploitations, not only in imparting valuable information, but in acting as guides to localities of interest. I am also indebted to the Southern Paçific Company, the Santa Fe System, and to Wells, Fargo & Co.'s Express, for favors extended.

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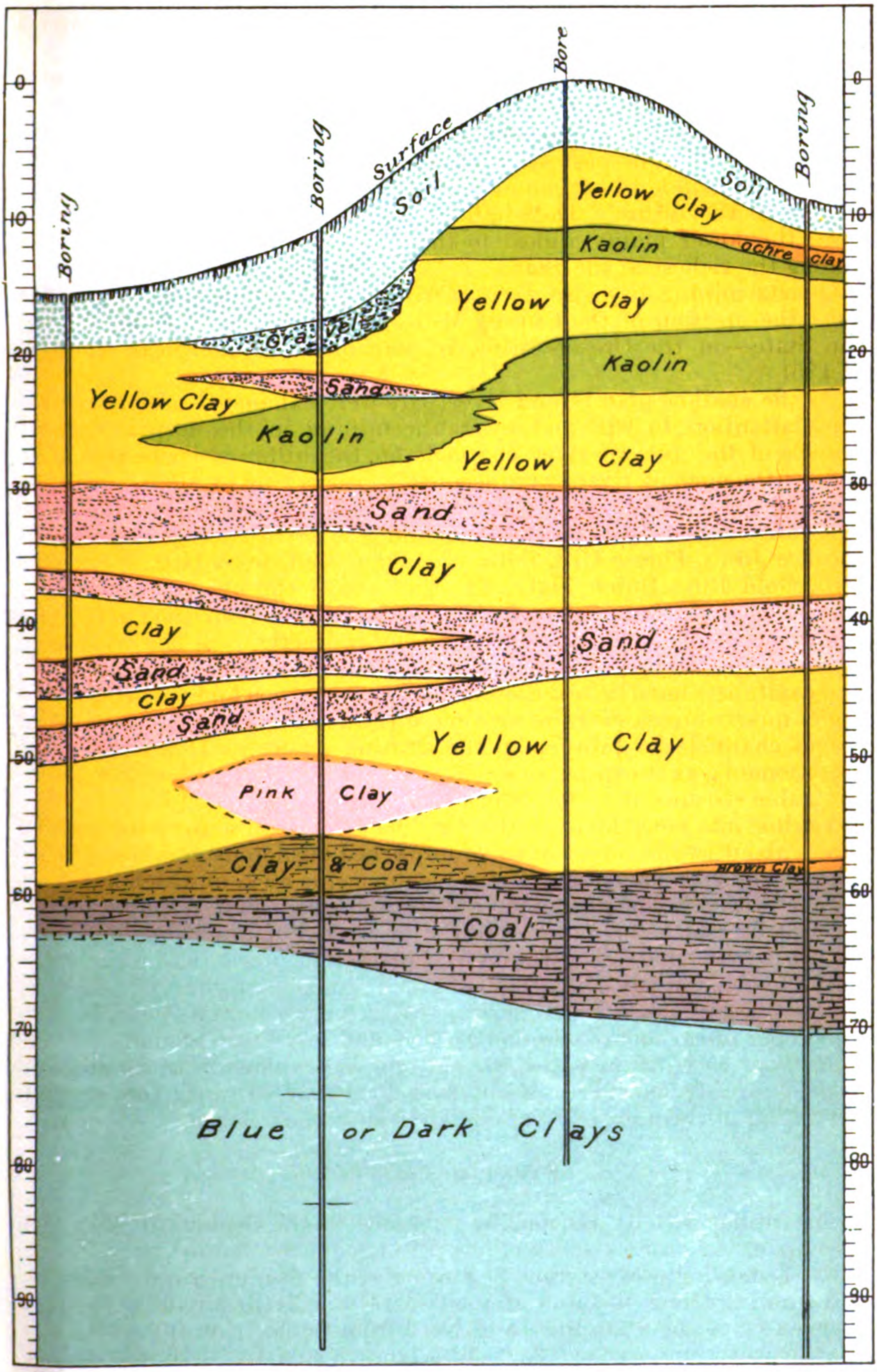
Plate I.



SKETCH SHOWING SEDIMENTARY FORMATION,
near LINCOLN. PLACER COUNTY. by J.B.Hobson.E.M.

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From an elevation of about two thousand five hundred feet up to the summit of the mountains we have snow in the winter season, light at the lower edge of the line, and increasing in depth as we ascend the Sierra. Here is a strip of territory from the snow line up to an elevation of three thousand feet, where the snowfall is not greater than in New England, and where the winter temperature is much higher. It is particularly well-adapted to the apple, the pear, and a great variety of vegetables.

At Auburn, the county seat, the average temperature for winter is 46.2 degrees; for spring it is 56.4 degrees; summer, 74.3 degrees; autumn, 61.7 degrees. The yearly mean of the maximum temperature at Auburn is 83.17 degrees; at Colfax, 85.42 degrees; at Rocklin, 84.33 degrees.

The average annual rainfall at Colfax is about forty-six inches, and at Auburn it is about twenty-six inches.

The soil of the western or valley portion of Placer County around Roseville, Lincoln, and Sheridan, is of the same general alluvial composition as all the soil in the great Sacramento Valley, and is well adapted to the growth of grain. Over thirty thousand acres are annually devoted to wheat, barley, oats, and hay. The low foothills back of Lincoln are excellent for the grape, and many new vineyards are springing up in that locality. They produce table grapes, wine, and raisins of superior quality.

The granitic belt from Rocklin to Newcastle is one of the foremost fruit districts of California. Its rolling lands are covered with orchards and vineyards. The chief fruits are the cherry, fig, nectarine, peach, olive, and orange, in all of which it excels. No other section produces earlier fruits, and it is estimated that for the last three or four years Placer County has shipped about one-seventh of all the green deciduous fruit sent East from California.

There are large shipping houses at Loomis, Penryn, Newcastle, Auburn, and Colfax. Newcastle does the heaviest forwarding business, and the total shipments from the county have increased from six million pounds in 1886 to seven million four hundred and fifty-nine thousand six hundred and eighty-eight pounds in 1887; twelve million pounds in 1888, and about the same proportionate increase for 1889 and 1890.

The decomposed granite soil of the fruit belt just mentioned requires plenty of irrigation for the best development of fruit and vegetables, and water is supplied in abundance by the Bear River Ditch, owned by the South Yuba Water Company. The main line of this ditch is sixty miles long, and its branches give the farmers of Placer a total of over one hundred miles of ditches for irrigating purposes. This service will be increased next year by the continuation of an old mining ditch, which now ends at Gold Run, to a point below Colfax, where the present Bear River Ditch comes out on the divide above Auburn. This new ditch will have a capacity of five thousand inches, and the same company will also build a new storage reservoir above Bear Valley, in Nevada County, to supply the increasing demand in Placer.

On the Bear River Ditch are many sites with available and valuable water-power. In two or three places ten or twelve hundred horse-power could be developed without serious waste of water, which would flow back into the ditch to be taken up again for other uses.

At Auburn the South Yuba Company owns a valuable storage reservoir for city water, and from its site to the lower part of the town there is a fall of over three hundred feet. The power thus acquired is already

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market, as there is hardly an orchard in the county distant ten miles from the railroad, and in the fruit belt there is a shipping house within easy reach of every farmer.

It does not require a prophetic mind to foretell the future of a district so favorably situated as this. The overland trains running through its entire length make its products a day nearer to the great eastern markets than those from other parts of the State, and if the "bugaboo" of "overproduction" should ever become anything like a reality, the fruits of Placer would still be first in demand because they are earliest and actually nearest to the great markets of the Northwest, and of Chicago and New York.

Placer, too, has the possibility of becoming a great manufacturing county. The discovery of clay at Lincoln a few years ago was the foundation of an immense pottery at that place, which is now annually turning out an amount of pottery, pipe, and terra cotta second to no other establishment in the West. The monthly wages paid to workmen in the Lincoln pottery amount to over $8,000.

A quality of sand suitable for plate glass, not as yet found elsewhere in the State, was also discovered at Lincoln about a year ago, and it has been known for years that there are coal beds in the immediate vicinity. These form a combination that may cause glass works to spring up that will rival the pottery in volume and value of business. This deposit of sand is of considerable length, running south from Lincoln to Roseville and even beyond.

The granite quarries are another source of revenue to the people of Placer. The inexhaustible quarries at Lincoln, Rocklin, Loomis, and Penryn afford stone of all shades from the lightest gray to an almost jet black when polished. Great quantities of this stone are free from iron, and the convenient railroad offers shipping facilities which makes quarrying for distant markets profitable.

The street curbing and granite fronts of San Francisco are nearly all from the Placer quarries, while the State Capitol, the Stockton Court House, and the Crocker monument are examples of the value and beauty of this foothill granite. The amount of business in this industry varies with the season, but it runs well up into the hundred thousands of dollars every year.

The lumber business is by no means the smallest of Placer's resources. A single firm has cut about two hundred and fifty million feet in Placer and Nevada Counties since it has been in business, while several smaller firms on the Forest Hill and Iowa Hill divides annually contribute their quota to the output. A new mill at Emigrant Gap is turning out about twenty thousand feet a day, and the recent organization of the Sierra Land and Lumber Company, which owns large tracts in the "French Meadows," above Michigan Bluff, will be the cause of soon opening up one of the finest timber belts now remaining in Central California. It is not unlikely that a narrow gauge railroad will be built from Soda Springs Station to this property in 1891.

The wood-pulp mill at Towles is also an important feature of Placer's industries. The output is used at the paper mill in Stockton.

Besides the immense deposits of gold in both the quartz and gravel deposits, there are found within the limits of the county ores of copper, iron, manganese, chromite, and silver (in the Ophir Mining District), and other minerals such as limestone, marble, steatite (soapstone)

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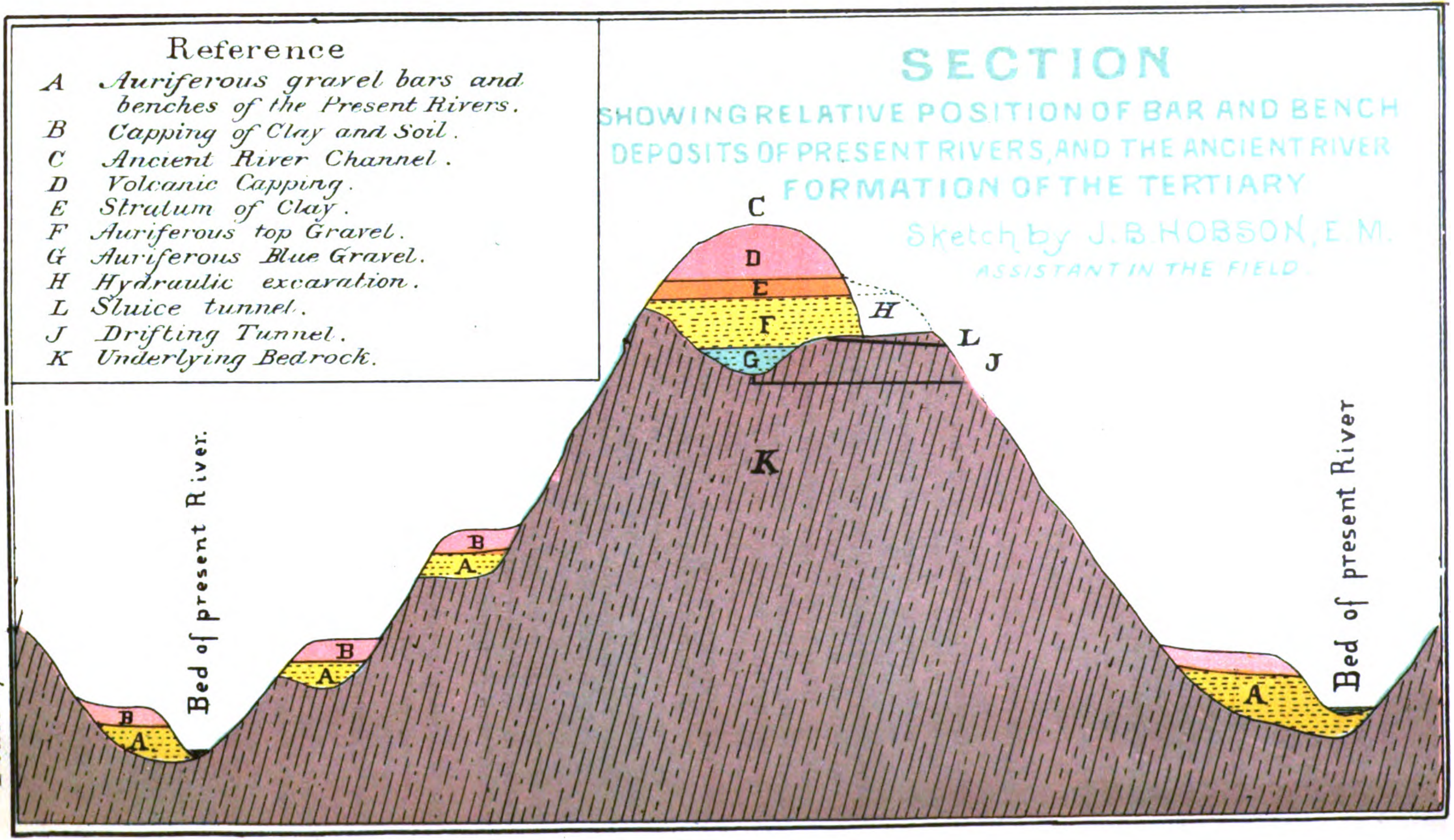
Plate 4.



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Hill and Last Chance. Throughout the above described region several gold-bearing veins are being prospected and worked with very flattering results.

West of the serpentine also are numerous promising gold-bearing veins, which have been located, and are being prospected and worked, the most important of which is the Drummond Mine, on Sec. 1, T. 14 N., R. 10 E., M. D. M.

The only fossils found during my examinations were ammonites, found in a peculiar belt of slaty rock which is about two thousand feet wide and forms the foot wall of the Sterrett Quartz Mine on Sailor Cañon. On top of the ridges the rocks are usually decomposed for a considerable depth, and covered with soil, and in numerous places are the beds of the ancient rivers of the Tertiary filled with immense deposits of auriferous gravel, in many places capped with volcanic debris and lava covering the ridges from cañon to cañon, and making it exceedingly difficult for the geologist to trace and correctly locate the contact and boundaries of the different belts and masses of rock. The rocks are well exposed in the deep cañons, become more firm and compact as you descend the deep eroded ravines and river canons, and near the beds are extremely hard and difficult to break.

The strike varies from north and south to a northwesterly and southeasterly course, with a dip nearly vertical, inclining slightly to the northeast, and are mainly Jurassic.

Numerous veins of quartz are seen cropping on the sides of the deep cañons, often crossing the beds and appearing on the opposite sides. The veins are usually in contacts and show strength; and the fact that in many places bodies of ore have been discovered in the veins near the beds of the deep cañons of the American and Bear Rivers, as well as on the tops of the ridges from one to three thousand feet above, is positive evidence of their permanence and gold-bearing qualities at great depth.

Along the beds of the deep river cañons are bar and bench deposits of auriferous gravel, varying from a few feet to one hundred feet in depth, and usually capped with a red ferruginous clay and red soil, some of them covering several hundred acres. (See sketch, Plate No. IV.) The formation of these bench deposits may reasonably be credited to the periods running from the Glacial through the Champlain, and including the recent.

These deposits were rich in gold, and were eagerly sought for and worked by the early gold miners; first, by aid of pick, pan, and rocker, followed by sluicing, drift, and hydraulic process. They were easily and profitably worked, and are, to a great extent, worked out in Placer County.

Some of the bars whose beds were below the present water level of the rivers, still remain and are being profitably worked by hydraulic elevators.

The Mammoth Bar Mining Company, located a few miles east of Auburn, on the Middle Fork of the American River, uses a hydraulic elevator, operated with four hundred miner's inches of water, discharged under a head of four hundred feet, to elevate the gravel from the bedrock, fifty feet below the present water level of the river, to the bank of the river above, where it is washed in sluices and the gold recovered. The output of gold, when the mine is running regularly, during the summer months, often reaches $1,000 daily.

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By reference to the Geological Map of the county, it will be observed that upon nearly every ridge or divide between Bear River and the South Fork of the North Fork of the American River are the lava-capped beds of the ancient rivers.

These deposits are also to be found on nearly all the ridges and divides between the South Fork of the North Fork of the American and the South Fork of the Middle Fork of the American River. By following either the gravel deposits, or remaining patches of gravel or capping, their general course can be readily traced from their source in the high Sierra to the plains. In the region north and south of Rocklin their beds are eroded, in the granite, below the present surface of the surrounding country.

These deep, well marked eroded channels near the lower plains, together with the numerous patches of Tertiary gravel and volcanic capping found on the ridges between the plains and the larger deposits at Gold Run, Iowa Hill, and Forest Hill, are almost positive proof that the ancient rivers in their course westward followed about the course marked by the remaining patches.

Assuming that they did follow a course within the limits of the remaining patches after leaving Gold Run, Iowa Hill, and Forest Hill, would account for the fabulous richness of the shallow placers in the vicinity of Auburn, Ophir, Newcastle, Gold Hill, and Virginia Town.

The shallow placers north of Dry Creek were very poor, and the fact that no gold was ever found in the region between the west branch of Dry Creek and New England Mills is certain proof that the ancient rivers never passed over that region.

The detail survey of the mines and contact of the Iowa Hill channel system proves conclusively that the Gold Run channel did not run southerly through Iowa Hill via Wisconsin Hill to Yankee Jims, as was originally supposed; but, on the contrary, the Iowa Hill, or what is known as the Morning Star, channel has a northwesterly course, and probably had its confluence with the Gold Run channel at some point where is now the cañon of the North Fork of the American, passing thence down the course of the cañon, leaving it and passing through the country between Secs. 21, 27, and 35, T. 13 N., R. 8 E., and flowing thence southwesterly in the direction of Auburn, connecting at Bowlder Ridge; thence on to the plains.

It is also probable that the Forest Hill channel passed along the course of the Middle Fork, leaving a volcanic-capped ridge at Bloomer Cut, and passing thence southwesterly connected at Lairds'; thence through the Chabot Mine and on to the plains.

In tracing ancient channels it is necessary to take into consideration the characteristics of the gravel and material composing the deposit, as well as a comparison of the size, shape, and fineness of the gold.

By making careful surveys of the contact of either the auriferous deposit or the volcanic capping with the underlying bedrock, it is possible with a reasonable degree of certainty to locate and reconstruct the system of watercourses now covered by accumulations of auriferous gravel and volcanic capping.

Such surveys would be of practical value to the miner and investor as a means of guiding them in their explorations, and of furnishing reliable data for the location of tunnels, often long and expensive, to tap the auriferous deposits.

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found, denoting the elevation of bedrock above sea level, and following the course indicated by dotted lines and arrows, the figures 2,685 will be found near the edge of the hydraulic bank.

At the workings of the Morning Star, in Indian Cañon, the elevation is two thousand six hundred and eighty-five and two thousand six hundred and fifty-one feet; and at the end of workings, northwest of the town of Iowa Hill, the elevations two thousand six hundred and forty-four feet and two thousand six hundred and thirty-one feet will be found, showing the point last mentioned to be sixty-one feet lower than the one at the southerly end of the channel, equal to a mean grade of three tenths of one foot to one hundred feet of channel.

In the Waterhouse & Dorn Mine the workings had not reached the bottom of the deep channel. The elevation, two thousand seven hundred and six feet, is on the rim and above the mean grade of channel bottom.

In the workings of the Morning Star Mine it will be observed that in the easterly workings the elevation of bedrock is much higher than the mean grade line of the channel bottom. This difference of level is explained, however, by the faulting and upheaval of large sections of the country rock and overlying deposits, as shown on map and section plates.

The Grizzly Flat channel, where working began, has an elevation of three thousand and sixty-three feet, and flow in the direction indicated by arrows, until the bedrock goes below the level of the working tunnel. This was extended about two thousand feet in the overlying deposit, and a winze was sunk which struck the bedrock at an elevation of two thousand nine hundred and twenty-six feet, where it was found pitching toward the west at an angle of about 40 degrees. The rapid pitch indicates a near approach to the bottom of the channel, which, so far as developed, shows a mean grade of four and five-tenths feet to one hundred feet of channel, and is tributary to the Morning Star channel.

In tracing the course of Succor Flat channel, commence at the bottom of incline in the Copper Bottom Mine, at an elevation of three thousand three hundred and ninety-nine feet; thence follow the course indicated by arrows through the workings in the Succor Flat and Strawberry Mines, noting elevations of bedrock; thence cross Indian Cañon into and through Roach Hill to the Phillips Claim; thence again cross Indian Cañon, and pass through the Trio and front of the Golden Gate Mine; thence continue southwesterly along the line of Indian Cañon, noting a bench in front of the Homeward Bound Mine, at an elevation of two thousand eight hundred and eighty-eight feet; thence follow in the same course to its confluence with the Morning Star channel on the north side of Indian Cañon, near Iowa Hill. The average grade will be found to be three and four-tenths feet for each one hundred feet of channel.

The Wolverine and Glencoe channels are tributaries to the Succor Flat channel, making their confluence as shown by workings in Roach Hill. The Golden Gate channel was probably eroded by the Grizzly Flat stream shifting its course after the fill and clay capping of the Morning Star system, at about the commencement of the volcanic period. The cross-section exposed in the Golden Gate Mine, shows plainly an erosion of the original deposit, and a fill of gravel and volcanic debris (foreign to the original deposit), covered with a heavy deposit of reddish colored sediment, and finally covered by volcanic capping.

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For the sake of convenience in description, the channels will be divided in this case into two classes: the system just described will be classed as primary, for the reason that its beds were eroded and filled prior to the volcanic period; and the system to be described as secondary, for the reason that its beds were eroded during the volcanic period. The gravel deposit found in them is almost entirely composed of rounded volcanic rocks, gravel, and debris. The auriferous deposit is usually thin, varying from less than a foot to four or five feet, rarely exceeding twenty feet in depth, and overlaid with volcanic capping.

The Long Point channel is of the secondary class. It crosses the ridge from Little Indian Cañon, going southerly to the McKinnon Claim at the end of Long Point. The elevation of bedrock in workings of Cumberland Claim, in Little Indian Cañon, is three thousand one hundred and ninety-one feet, and the elevation is three thousand and seventy-four feet at the McKinnon Claim, on Long Point, showing an average grade of eight tenths of one foot in one hundred feet of channel.

A shaft sunk in the Attallus Claim and one in the Cumberland indicate the probability that they are on a small tributary, as shown on Iowa Hill map.

After leaving the McKinnon Claim, the stream probably flowed southerly, entering the Forest Hill Divide, where its course will be traced and shown on the maps of that region by Mr. Ross E. Browne.

The Vigilante channel is of the same class as the one in Long Point. Its bed at the upper end of Vigilante workings has an elevation of three thousand and thirteen feet, and its course is southerly, making a bend to the west from the Lermond Claim, crossing what is now the bed of Grizzly Cañon, passing in the shape of a horseshoe through Webber & Co.'s claim, and thence out through Stone's claim at an elevation of two thousand eight hundred and seventy-two feet. The mean grade is one and seven tenths feet to one hundred feet of channel.

The cross-section plates show the relative position and elevation of beds of present and ancient rivers. Plate I (section on line from A to B, see map) illustrates bed, gravel deposits, and capping of Morning Star, Wolverine, and Glencoe channels. Plate II (section on line from C to D) illustrates beds of Morning Star, Grizzly Flat, Golden Gate, Long Point, and Succor Flat channels. Plate III (section on line from E to F) illustrates beds of Vigilante and Long Point channels; also, the probable position of Grizzly Flat channel prior to the erosion of Grizzly Cañon. Plate IV (section on line from G to H) illustrates beds of Morning Star, Grizzly Flat, Golden Gate, Vigilante, and Long Point channels, and the workings of Drummond Quartz Mine.

Longitudinal section plates are drawn on line following the beds of the different channels.

The fill of the Morning Star channel for a depth varying from sixty to one hundred feet next the bedrock is made up of rounded bowlders, cobbles, gravel of metamorphic rock, and sand cemented together with lime, iron, and silica, forming a very hard conglomerate, which cannot be mined without the aid of powder, requiring also the aid of stamp mills to crush and disintegrate it so that the gold it contains can be separated and recovered. This hard cement has a light bluish gray color, and is known as blue gravel, often carrying a large percentage of iron pyrites. There is but a small percentage of quartz in the bottom, or blue gravel, and the sand contains a large percentage of mica, indi-

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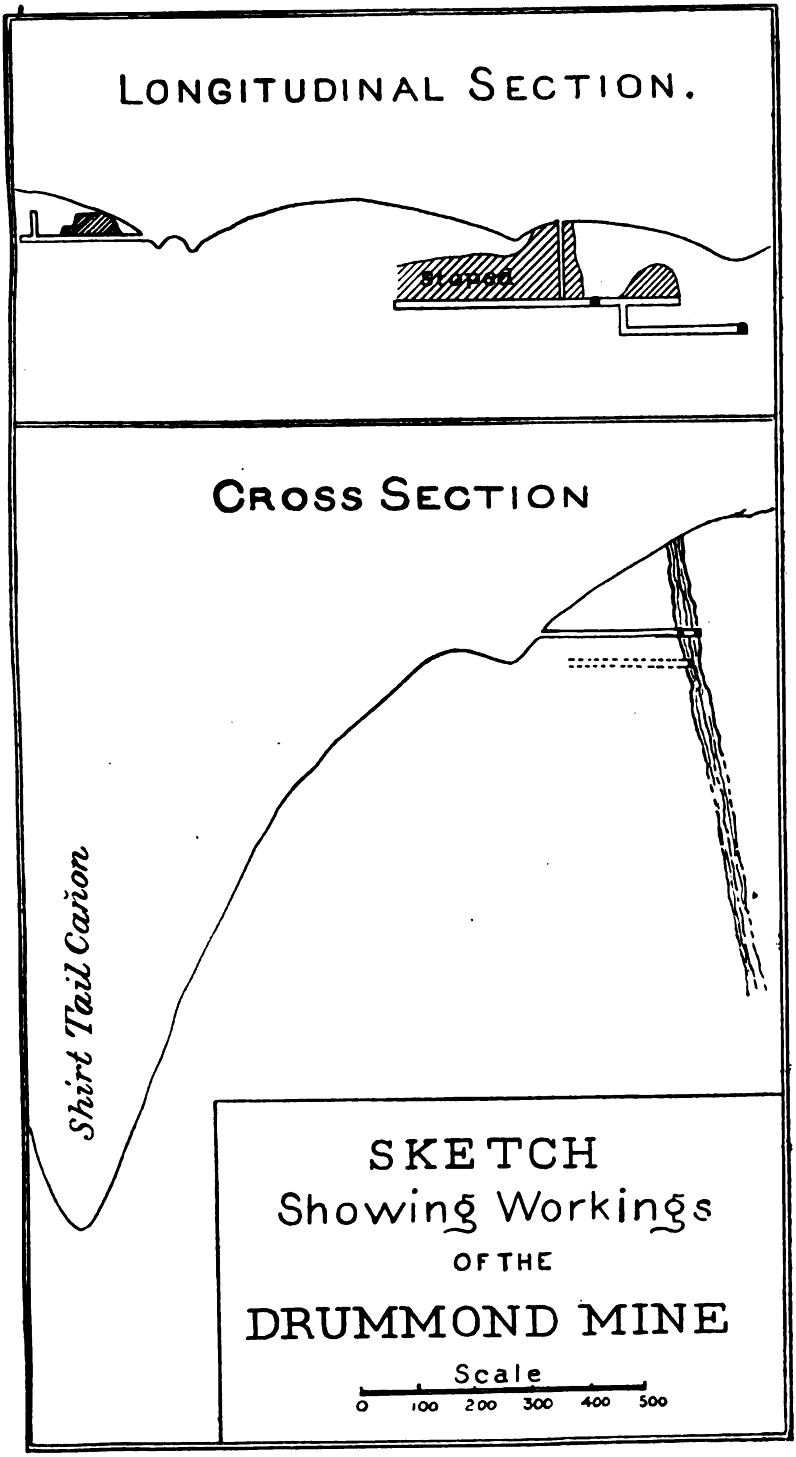

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GOLD RUN DISTRICT.

This district is situated on the line of the Central Pacific Railroad. It was, a few years ago, one of the most flourishing hydraulic mining regions in the State. The mines are all idle, having been stopped by anti-debris injunctions. The once prosperous town bearing its name is almost deserted, and the few old miners remaining eke out an existence by crevicing and cleaning bedrock in the old hydraulic pits.

The district covers an immense ancient river channel filled with a deposit of auriferous gravel to a depth of about four hundred feet, the deposit between rims being about a mile wide. In places the top gravel was worked in two benches of one hundred and fifty feet each, leaving the bottom or blue gravel remaining. This bottom gravel is known to be rich, as it had just been opened by a long and expensive bedrock sluice tunnel, and worked sufficiently to prove its richness. The time, however, is not far distant when attention will be directed to opening up the deep channel for working the cemented bottom gravel by drifting process, and crushing it in stamp mills. If so opened, it would give employment to a large number of men for a great many years.

DUTCH FLAT DISTRICT.

This district was also a flourishing hydraulic district prior to the anti-debris litigation. The mines are all idle, and the once prosperous town bearing its name is partially deserted and going to decay.

The bottom gravel is known to be rich, and an effort is being made to consolidate a number of the claims on the channel, and raise funds to drive a tunnel and open the channel for drifting.

OPHIR MINING DISTRICT.

This district is about two miles north of Newcastle on the line of the Central Pacific Railroad.

The country rock is syenitic granite and syenite, with narrow belts of schistose rocks; and dikes of diorite are usually found walling the numerous veins of quartz.

There are fifty-three or more quartz mining locations and claims in the district, all of which have been more or less worked at intervals since 1851.

The deepest workings were prosecuted in the Crater Mine to a depth of eight hundred feet.

The ores in a great majority of the mines are high-grade, but of such a rebellious character that they cannot be profitably worked by the free-milling process. The rebellious ores are quartz, containing besides free gold, a large percentage of argentiferous galena, tellurides, zincblende, and the sulphides of antimony, arsenic, copper, and iron.

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A number of the mines, however, have shoots of free-milling ore.

The South Yuba Canal Company supplies water to all parts of the district, affording a cheap and reliable power for hoisting and milling machinery. (See map of Ophir and Duncan Hill Districts.)

Hathaway Mine.

This mine is located about three quarters of a mile southwest from the town of Ophir, on the south side of Auburn Ravine, at an altitude of seven hundred and sixty-five feet, and consists of a location six hundred by eighteen hundred feet.

The ore vein is quartz, three feet wide, carrying argentiferous galena, zincblende, and pyrites containing copper, arsenic, and iron.

The course is north 75 degrees west, and the dip 75 degrees to the south. The foot wall is syenite and the hanging wall talc schist.

The upper level of the mine is worked through a tunnel fourteen hundred feet in length, and the lower levels through a shaft two hundred feet deep. (See plan of workings.)

The ore shoot is about twelve hundred feet in length, having a pitch of 60 degrees to the east. The main shaft is being sunk to open another level. The water in the mine averages nine thousand gallons in twenty-four hours, and is hoisted with buckets.

The mill has twenty stamps of eight hundred and fifty pounds each run by a four and a half foot Knight wheel, driven by water delivered under a head or pressure of two hundred and thirty feet. The mill is provided with rockbreakers, also four of Hendy's Challenge ore feeders, and four Woodberry concentrators. The method of treating ore is free-milling, amalgamation in battery and on silver-plated plates, on aprons four and one half by twelve feet having an inclination of one inch to one foot. Plates inside battery are five by twenty-four inches. The sulphurets are sent for treatment to chlorination works. The percentage of sulphurets saved is $1\frac{2}{3}$ per cent, valued at $230 a ton.

The hoisting works is run by a six-foot Pelton wheel, driven by water delivered under a pressure of one hundred and ninety-five feet. Sixty-two miner's inches of water measured under a four-inch pressure are required to run both mill and hoisting works.

Altitude, aneroid reading	765 feet.
Course of vein	North 75 degrees west.
Dip of vein	South 75 degrees.
Average width of vein	3 feet.
Character of foot wall	Syenite.
Character of hanging wall	Talc schist.
Length of ore shoot	1,200 feet.
Vertical depth reached by workings	200 feet.
Length of first level tunnel	1,400 feet.
Length of second level	900 feet.
Number of stamps	20.
Weight of stamps	850 pounds.
Drop in inches	$5\frac{1}{2}$.
Drops per minute	92.
Duty of stamp in twenty-four hours	$1\frac{1}{2}$ tons.
Water used in battery	$1\frac{1}{2}$ inches.
Kind of screen	No. 35 wire.
Size of apron	$4\frac{1}{2}$ by 12 feet.
Kind of feeders used	Hendy Challenge.
Percentage of value saved in battery	60 per cent.
Percentage of value saved on plates	20 per cent.
Percentage of value saved on concentrators	20 per cent.
Kind of concentrators	Woodberry.
Percentage of sulphurets saved	$1\frac{3}{4}$ per cent.

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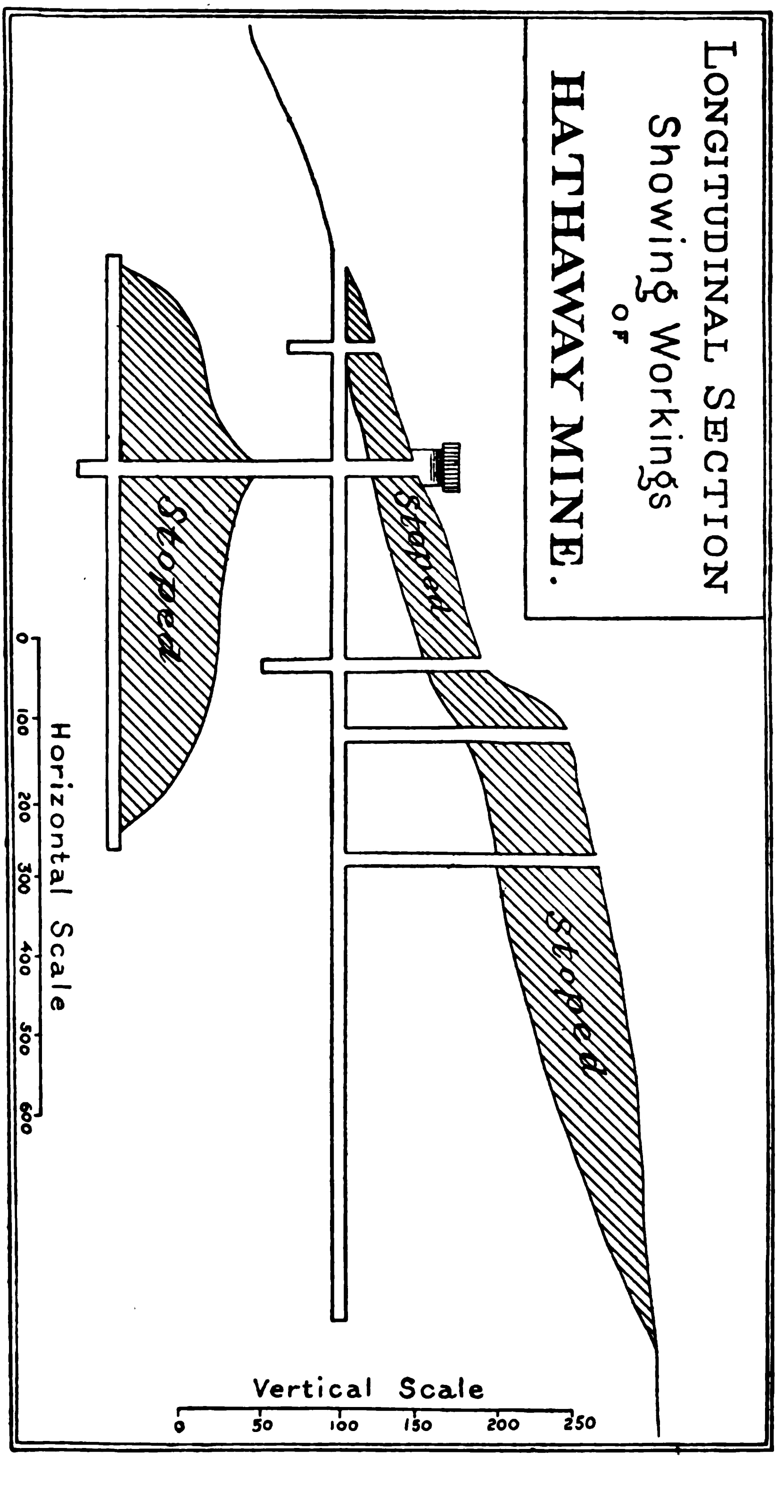
LONGITUDINAL SECTION
Showing Workings
OF
HATHAWAY MINE.
Stoped
Stoped
Stoped
Horizontal Scale
0 100 200 300 400 500 600
Vertical Scale
0 50 100 150 200 250

Value of sulphurets per ton	$230.
Nature of sulphurets principally	Galena and iron pyrites.
Kind of power	Water.
Number of men employed in mine	22.
Number of men employed in mill	4.
Number of men employed on outside work	5.
Wages of miners per day	$2 50.
Wages of millmen per day	$3.
Wages of men on outside work	$2 50.
Amount of water used for power to run mill and hoisting works	62 inches.
Cost of water per inch, twenty-four hours	12½ cents.

Gold Blossom Mine.

This mine is located about one and one half miles northwest of the town of Ophir, on the north side of Auburn Ravine. The property includes the Gold Blossom and Ohio Claims, covering about eighteen hundred feet of the Gold Blossom lode, and also a strong spur known as the Marion lode.

The Gold Blossom vein is two feet wide; the course is north 80 degrees west, and dip about 85 degrees south. The foot wall is syenite, and the hanging wall diorite. (See plate showing workings.)

The foot wall of Marion vein is chlorite schist, and the hanging wall syenite. Both veins are worked through a shaft two hundred and eighteen feet deep, from which there are driven two levels. The first is five hundred and eight feet, and the second two hundred and eighty-nine feet in length. A crosscut is driven north from the 180-foot level to the Marion vein, which is about twenty inches wide, similar to that extracted from the upper levels. The length of ore shoots has not been determined.

There is a ten-stamp mill on the property, provided with a rock-breaker, Triumph self-feeders, and a system of canvas blanket tables for concentrating sulphurets; also, a Frue concentrator for secondary concentration of the sulphurets saved on canvas tables.

The ore contains, besides free gold, a large percentage of argentiferous galena, zincblende, and pyrites containing copper, iron, and arsenic.

The ordinary class of ore is worked by amalgamation in the mill and on the plates. The sulphurets are saved on canvas blankets and dressed up by the Frue concentrator. The heavily sulphuretted ore is selected and shipped to smelting works for reduction. Both sulphuretted ore and concentrates are of high grade. The percentage of sulphurets saved is 2½ per cent.

The following gives the result obtained from lots of ore and sulphurets worked at Reno and Salt Lake City:

Reno, February 18, 1889.

Reno S., M., and R. Works, bought of Gold Blossom Mine, Ophir, California.

15,714 lbs. sulphurets:	
Assay per ton: gold, $17 55. 90 per cent	$137 89
Assay per ton: silver, $57 04. 90 per cent	360 91
3,247 lbs. of sorted ore called No. 2:	
Assay per ton: gold, $54 23. 90 per cent	79 23
Assay per ton: silver, $72 92. 90 per cent	53 27
487 lbs. No. 1 sorted ore:	
Assay per ton: gold, $220 93. 90 per cent	48 36
Assay per ton: silver, $72 92. 90 per cent	15 97
	$695 63
Charges and reduction, etc.	196 16
Amount remitted	$499 47

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THE ANCIENT RIVER BEDS OF THE FOREST HILL DIVIDE.*

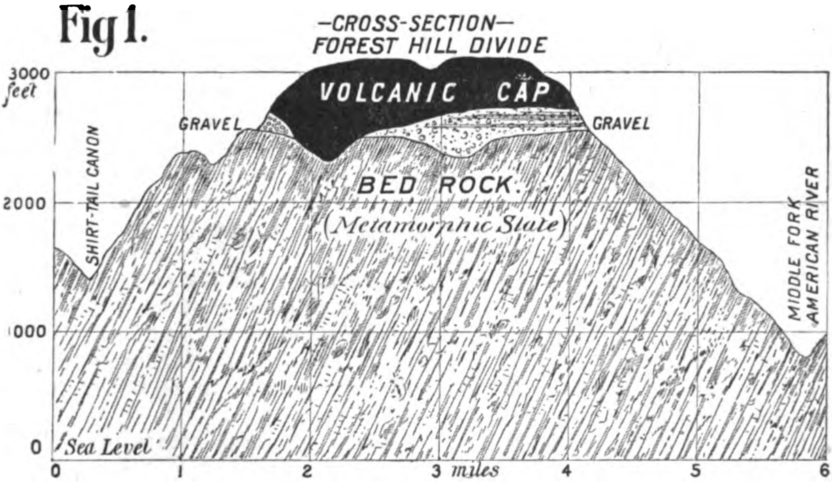
By Ross E. Browne, Mining Engineer.

The Forest Hill Divide is situated in Placer County, between the North and Middle Forks of the American River. It is one of the numerous spur-like ridges of the western flank of the Sierra Nevada.

The ridge-line is uniformly graded and unbroken for twenty-five miles or more, extending from an altitude of five thousand eight hundred to two thousand three hundred feet above sea level. Midway between these points the ridge branches, the northerly branch being the Iowa Hill Divide, and the southerly, or main branch, the Forest Hill Divide proper. The general course is south of west, or approximately normal to the axis of the main Sierra Range.

At certain favorably located points an extended view is obtained of this and neighboring divides. Upon losing the effect of the detail one receives the impression of a general uniformity in the grades of the summit-lines. These summit-lines appear as the remaining traces of a gently undulating plane, sloping regularly from the bases of the massive peaks of the Sierra to the Sacramento Valley. One readily conceives the idea that the deep cañons and gulches, which give to the modern surface its broken and rugged character, are but the results of the prolonged erosive action of the present streams.

Fig 1.



An examination of the district shows that the bases and main bodies of these ridges are composed of metamorphic rocks of great age; and that there are commonly exposed on the summits large accumulations of volcanic material and extensive river deposits of a comparatively

* A map accompanies this article.

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recent geological epoch. In a popular sense, however, these deposits are decidedly ancient, and they have been appropriately credited to an ancient river system.

A characteristic cross-section of the Forest Hill Divide is given in Fig. 1.

The Metamorphic Rocks forming the base and main body of the ridge and constituting the country rock of the district are commonly slates, carrying seams and ledges of gold-bearing quartz. The slates vary in character; they are finely laminated or coarse and blocky, talcose, argillaceous, or highly siliceous. There are several belts of soft laminated slate in which the quartz ledges and seams are specially numerous.

The strike of the slates is generally between north and northwest, and the dip 75 degrees to 85 degrees to the east.

Prominently exposed are patches and dikes of diorite and a broad zone of serpentine.

The term "bedrock," though evidently intended to apply only to the rock immediately forming the bed of the river, is nevertheless used in a general way to designate the country rock of the district.

The River Deposit consists of well washed bowlders, pebbles, and sand, composed of the harder materials eroded from the bedrock—mostly quartz and siliceous rocks. Clay strata are of frequent occurrence, particularly in the upper portion of the deposit. Trunks of trees, commonly cedars and oaks,* are found imbedded in the upper layers, either petrified or somewhat lignitized. Certain layers of the gravels thus formed have become strongly cemented, owing, probably, to the percolation of siliceous and calcareous waters. The color is gray, blue, green, reddish brown, or white, according to the material, as well as the degree of oxidation of the iron contained in the cementing substance.

Gold occurs throughout this deposit in the form of rounded nuggets, scales, and dust (see Fig. 12). This occurrence is the result of the breaking and grinding of fragments and bowlders of the gold-bearing portions of the bedrock. By a natural process of concentration the bottom layer of each deposit of gravel has become, as a rule, the richest.

That these auriferous gravels are river deposits, was but one of a number of the theories advanced during the first decade of active mining operations. The theory was well established, however, by Professor Whitney in his earlier work as State Geologist, and the accumulating evidences have long since become conclusive.

The Volcanic Cap consists of massive layers of beds of light gray, reddish brown, and dark-colored cements and conglomerates. It contains large bowlders and fragments of volcanic rocks, and in its bottom layers occasional trunks and branches of trees somewhat lignitized. It carries no appreciable quantities of gold, and is, in fact, the barren material of the district.

Between these massive beds are layers of gravel, marking distinct periods in the flow.

Doubtless the volcanic cement was originally in the form of a semi-plastic fluid, or mud, solidifying or "setting" soon after depositing. Some of the gray and dark-colored cements are as firm as an artificial concrete, and resist the erosive action of the water better than the softer, finely laminated slates.

**I. e.*, trees similar in appearance to our present cedars and oaks.

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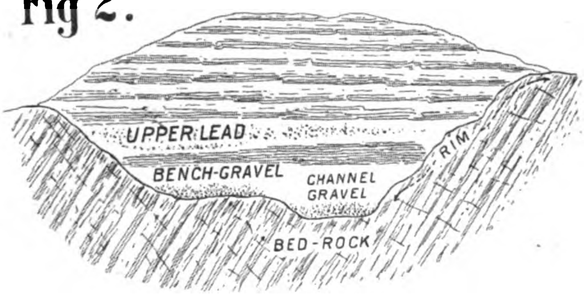
Mining Developments.—The Forest Hill Divide has been for thirty-nine years an active field for mining enterprise. There have been exposed by hydraulicking many sections of the river deposit and extensive areas of the river beds; and by drift mining a number of the channels have been explored and worked continuously for a mile or more of their lengths. The principal developments are indicated upon the accompanying map.

Fig 2.



Mining Terms.—Of the mining terms used it appears necessary to define a few only: "Channel" refers to the deeper portion of the continuous trough-like bed of the river; "rim" to the sides of the trough, from the line above where the bedrock begins to pitch down, to the shore line of the bottom layer of gravel filling the channel; "upper lead," to an upper layer of pay gravel; "bench gravel," to a patch of an earlier deposit of gravel remaining in place after the greater portion has been washed away.

THE CHANNEL SYSTEMS.*

The network of channels under the volcanic cap is rather confusing. There are evidences of a number of channel systems, each representing a partial or complete displacement of the stream, a distinct cut, and a special deposit of gravel.

The series of volcanic eruptions in the high Sierras had a marked effect upon the watercourses and has enabled a ready grouping of the channel systems according to three important periods, covering the time before, during, and after the series of eruptions.

First Period.—Prior to the first important flow of volcanic cement, this period is represented by a system of continuous valley-like depressions in the bedrock, from a thousand to several hundred feet in depth and several miles in width, and containing broad river beds filled with gravel to very considerable depths. The rivers, in eroding the bedrock and forming these depressions, left a succession of broad, flat benches with shallow accumulations of gravel.

The channels naturally followed, to a great extent, the belts of soft slate. This slate is easily eroded, slacks readily, and is washed away in the form of a fine silt. Quartz is the only important material contained in the belts which is hard and permanent enough to resist the destructive action of the current. Owing to these facts we find in the filling of the channel, for long stretches, quartz gravel and quartz sand

*The term "channel system" herein refers to the beds of contemporary streams.

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The watercourse was several times diverted by the heaping masses of volcanic materials. During the intervals between the periods of volcanic eruption both shallow and deep narrow channels were cut, sometimes following and partly obliterating the older deposit, sometimes crossing and leaving the deeper portion of the older bed altogether. Some of these later cuts are higher than the earlier; several of them, however, passed entirely through the older deposit and fifty to one hundred feet deeper into the bedrock. (See Figs. 3 and 4.)

The "blue channel" and the "volcanic gravel channel," shown in the section, represent two such cuts.

The "blue channel" contains, in its lowest depression, five to fifteen feet of bedrock gravel of a grayish blue color,* and on top of this eighty feet of cement, then a layer of four or five feet of bedrock gravel; and on top of this again, cement.

The "volcanic gravel channel" contains a large body of coarse gravel, composed mostly of volcanic rocks, and to a small extent only of bedrock.

These two channels represent distinct systems. The volcanic gravel channel is doubtless the later of the two; possibly the latest of the deep channels of the period.†

The final bed of the period was filled with coarser cements and conglomerates to a great depth. Volcanic eruptions in the high Sierras ceased altogether, and thus the cause of frequent diversions of the watercourse disappeared.

Third Period, immediately following the last important flow of volcanic cement and extending to the present time.—There still remains of the volcanic cap from three hundred to one thousand feet in depth. The ancient valley was filled to depths even greater than these, and there resulted a wider and more permanent diversion of the watercourses than heretofore. The streams started new channels, probably along the marginal lines of the cap, cutting across the cap at the juncture of tributaries of early periods, and ultimately obliterating the greater part of the deposits of the first period and a large part of the deposits of the second period.

These streams, undisturbed by volcanic activity, have continued to cut, forming eventually as the forks of the American River the deep cañons of the present day. The following series of sections will illustrate this conception of the transformation of the original surface, and the extent of the cutting and filling of the three periods (see Fig 5). The surfaces marked 1 are sections of the gravel deposits of the first period, and those marked 2 are sections of the volcanic cement deposits of the second period.

Distinctive Features.—From the frequent displacement of the streams during the second period, there have arisen various complications in the channel systems. Although the mining developments are extensive in portions of the district, it still remains a difficult matter to separate the channel systems of the second period, and it is not always easy to distinguish between those of the first and second periods.

In a general way, it may be said that the channels of the second period

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* In this article "bedrock gravel" means gravel composed of bedrock material; "cement," volcanic cement; "volcanic gravel," gravel composed of volcanic rocks more recent than the channel systems of the first period.

† See Appendix B to this article.

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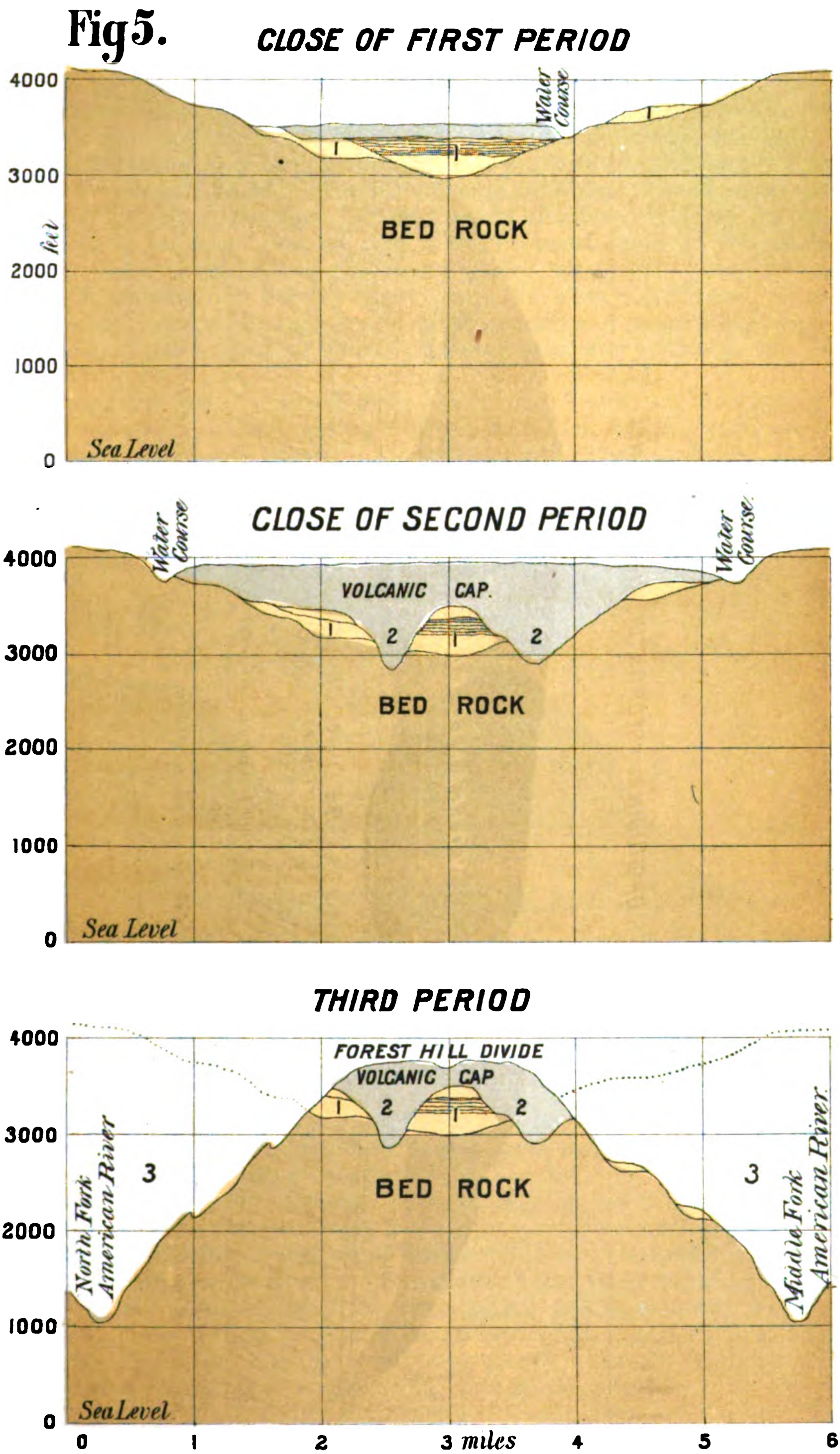

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differ from those of the first as follows: their beds are narrower, rims steeper, and accumulations of bedrock gravel incomparably smaller.

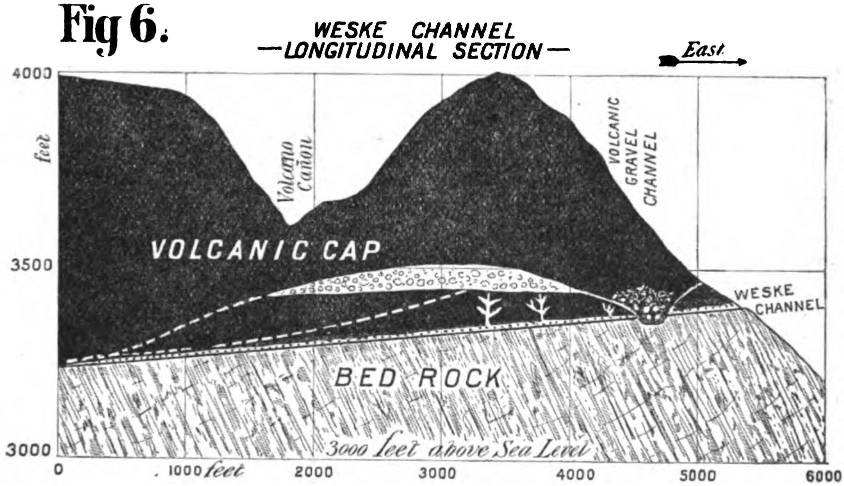
The following may be said concerning the gravels in the deeper channel bottoms, and their immediate volcanic cappings: The characteristic channel deposit of the first period consists of a large body of gravel of exclusively bedrock material, and a light cement capping; the characteristic channel deposits of the second period, either of a small body of bedrock gravel and a heavier cement capping, or of a large body of volcanic gravel and a heavy volcanic conglomerate and cement capping.

A continuous cap of so called pipe-clay generally indicates the first period.

Where one deep channel cuts across the deposit of another, the channel which does the cutting belongs, as a rule, to the second period. The channel which has been cut may belong to either period.*

Gravel Dislodged and Redeposited.—There occurs occasionally very large accumulations of bedrock gravel between the deposits of volcanic cement, which are evidently the result of the cutting and dislodgment of sections of the older deposit. (See Fig. 6).

Fig 6.



The upper body of quartz gravel shown in the figure is such an occurrence. It has not been explored to any great extent, and the limiting lines in this section are conjectural.

Buried Trees.—The section given in Fig. 6 shows an interesting occurrence. The cement filling the bed to a depth of one hundred feet is a more uniformly fine-grained sediment than is commonly encountered. It incloses a number of oak and cedar trees standing on the banks of the channel, with the roots intact in the gravelly soil and bedrock. One of these is a cedar nearly one hundred feet in height and four feet in diameter at the base, and stands perfectly upright, and, considering its age, is in a surprising state of preservation.

*A careful study of the immediate volcanic caps of the gravel deposits by a competent specialist in petrography may lead to important criterions in classifying the channels. It will be evident that the writer's opportunities have been mainly for a study of the topographical features.

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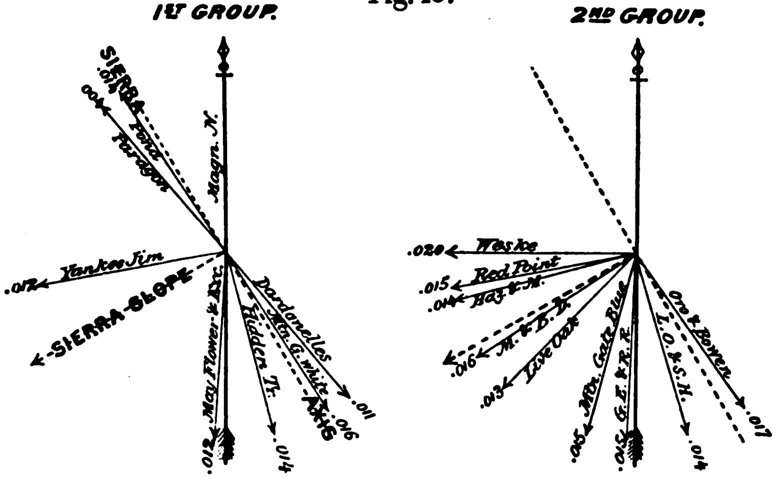
Fig. 10.



Professor Whitney, in his work on "Auriferous Gravels," after discussing the date of uplift of the Sierra, says: "We may assume that orographic causes may pretty much be left out of consideration in the discussion of what has taken place since the gravel was deposited."

Prof. Jos. Le Conte, in his paper on the "Old River Beds of California," attributes the cutting of the new channel, below the level of the old, to a considerable elevating of the Sierra Range, and increase of the mountain slope. The question on which the two authorities differ so widely in opinion is an important one in tracing the old channels. If, for example, Professor Le Conte's view is correct, and the bearing of the axis of upheaval is north and south, and the tilt to the west, one should expect to find, in following the sinuous course of the tilted channel: First, the original grade maintained wherever the course is north or south; second, a greatly increased grade wherever the course is west; third, little or no grade wherever the course is east. It is plain that a systematic study of the grades promises not only a settlement of the main question, but perhaps also the determination of the bearing of the axis, and the magnitude of the tilt, if any occurred.

The information furnished in the above diagrams (Fig. 10) is rather meager. More data are wanted to settle the question of tilting. However, it may be said that the evidence, as far as it goes,* is against any considerable increase in the slope of the Sierra flank—decidedly against an increase large enough to account *per se* for the two thousand feet deeper cutting of the modern river.

Local Disturbances.—There appears to have been very little local disturbance of the channels through faulting.† The writer has observed only one well marked case in the district covered by the map.‡ A fault passes across the bed of the Yankee Jim channel. The strike is north 35 degrees west magnetic. The throw is to the northeast fifteen feet, and

* The Dam and Rainbow are forks of the same channel. Their grades disclose no tilt.
† This absence of local disturbance is a further indication that no marked uplift of the Sierra Range has taken place since the period of the ancient channels.
‡ See Appendix C to this article.

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almost vertical, making the down-stream bed fifteen feet higher than the up-stream. The gravel has been washed away by hydraulicking, but it is plain that the fault extended through the gravel deposit, as the wall shows no wash and its edge is rough and angular.

Origin of Quartz Gravel.—The enormous accumulation of quartz gravel in the white channel of the Mountain Gate and Hidden Treasure Mines is a matter of some interest. A large number of the smoothly washed bowlders are from three to six feet in diameter, and weigh from one to ten tons each. One of the largest encountered had a smoothly washed surface and was between ten and twelve feet in diameter, weighing over fifty tons. It does not appear likely that the heavier of these moved very far after reaching the rough bottom of the river bed, and the surfaces were probably polished by the sharp quartz sand in the swift current. Still the great mass of the material was doubtless derived from a source far above these sections.

In extracting the gravel and exposing the channel bottom there have been found a number of large quartz ledges. One of these measured thirty-four feet in width. Still the amount of quartz thus seen in the bedrock does not appear as sufficient to account for the filling of the channel. One is led to assume that the size of the quartz ledges, or their number, further up stream and perhaps nearer to the original surface, was greater than in the bedrock now exposed in the channel bottom.

Bench Gravel.—Numerous benches on the rims of the larger channels have been worked with profit. Owing, however, to the uncertainty regarding the extent of such benches when buried under the volcanic cap, there has been very little prospecting for them in the principal drift mines.

High up on the west rim of the present El Dorado Cañon are a number of benches which have been hydraulicked with profit. Several of these are shown on the map. The Batchelder, Franklin, Drummond, and El Dorado Hill deposits are doubtless more recent than the ancient channels under the volcanic cap. The gravel of the Gas Hill and Big Gun pits is practically the same as that of the Mountain Gate and Hidden Treasure white channel—there is good reason for thinking that these are remaining patches of the same channel deposit.

Courses of the Channels.—The courses of the channels placed upon the map appear to the writer as pretty definitely indicated by the data. The periods to which these channels are thought to belong are indicated by the coloring. (See note on map.)

In this connection attention is called to the "Review and General Discussion" of Mr. W. A. Goodyear, pp. 488 to 526 of Whitney's "Auriferous Gravels." Mr. Goodyear's foresight in outlining the courses of certain channels, at that time (1871) but imperfectly developed, is noteworthy. He indicated approximately the course of the Mountain Gate white channel several years before the discovery of the Hidden Treasure, and pointed out the probability of the bend in the Paragon channel many years before the May Flower discovery was made.

Depth of Gravel.—The depth of bedrock gravel wholly under the volcanic cap is, as a rule, from thirty to one hundred and seventy-five feet in the channels of the first period, and from a few inches to twelve or fifteen feet in the channels of the second period.

Width of Channels.—The character of the bedrock seems to have had

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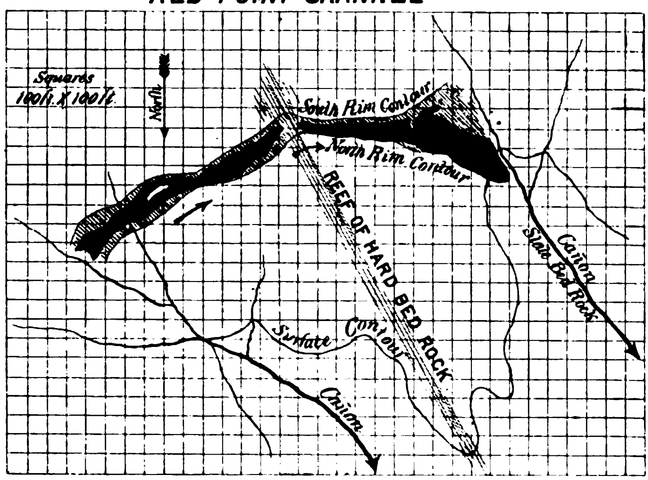
an important influence on the width of the channel, the course, and pay. The old river was frequently narrowed down and turned by contact with belts of the harder of the metamorphic rocks.

The following plan of the Red Point Mine is a good illustration of the effect of the hardness of the bedrock upon the width of the channel and the amount of gravel deposited:

Fig 11.

RED POINT CHANNEL



The black surface represents the amount of gravel extracted, and practically the entire extent of gravel in the channel bottom. Where the channel crossed the hard reef it was narrow and contained no gravel, the volcanic cement resting immediately on the bedrock.

The Gold.—Fig. 12 gives a fair idea of the sizes and shapes of the gold nuggets and scales occurring in the gravel of the Red Point Mine. The fineness of this gold is about 0.930.

The greater portion of the gold is of medium size or fine and flat or scaly.

The gold from the blue channel of the Mountain Gate Mine, and from the Paragon and May Flower channel, is about the same as that from the Red Point. That from the white channel of the Mountain Gate and Hidden Treasure and from the Weske is somewhat coarser. Nuggets weighing one or two ounces are not uncommon; they seldom weigh as much as ten or fifteen ounces.

The distribution of the gold in the gravel is not always the same, though as a rule the bottom layer of gravel is the richest.

The Weske channel, it is stated, has yielded good pay on high benches. In one portion of the Dardanelles Mine, pay gravel was extracted in floors to a height of thirty-five feet above the channel bottom. The upper lead of the Paragon Mine—one hundred and sixty feet above the channel bottom—has yielded by drifting more per running foot of channel, though less per ton, than has the bottom lead. (See tabular statement.)

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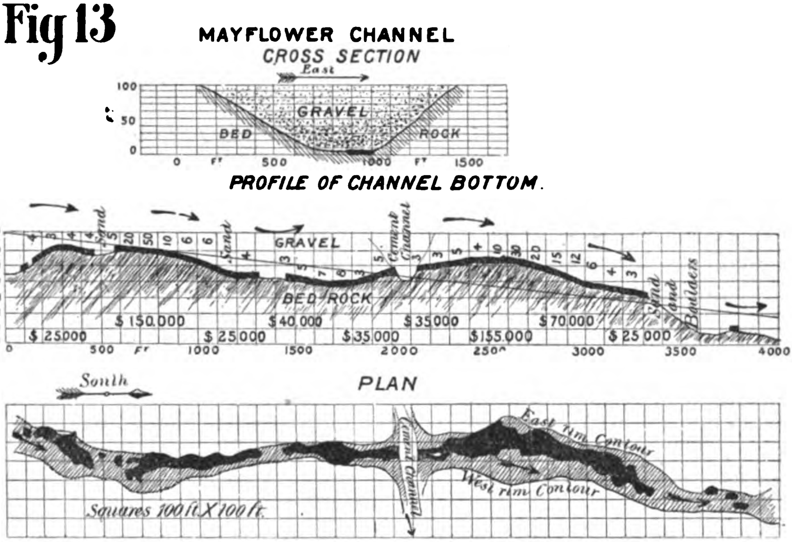
the plan and longitudinal section, or profile, of the bodies of pay gravel extracted (in black), and the plan of rim contours ten feet above the channel bottom. There are further given, in small figures, the total amount of gold extracted from various sections and the average yield in dollars per ton of gravel (ranging from $3 to $50) at intervals of one hundred feet.

Fig 13



The average grade of the May Flower channel is twelve feet in one thousand.

Yield of the District.—The writer has been wholly unable to obtain a reliable estimate of the total yield of the district represented on the map. Apparently it is about $30,000,000.

The following figures may be wide of the mark, as they are based on hearsay evidence, except in a few cases where comprehensive accounts were available:

Red Point, blue channel, drifting	$150,000
Mountain Gate, white channel, drifting	600,000
Mountain Gate, blue channel, drifting	175,000
Hidden Treasure, white channel, drifting	1,150,000
Weske channel, drifting	750,000
Michigan Bluff District, mainly hydraulicking	5,000,000
Paragon, bottom lead, drifting	850,000
Paragon, upper lead, drifting	900,000
Paragon, hydraulicking	500,000
May Flower, bottom lead, drifting	585,000
Forest Hill District, drifting and hydraulicking	5,000,000
Dardanelles, hydraulicking and drifting	2,000,000
Todds Valley District, mainly hydraulicking	5,000,000
Yankee Jim's District, mainly hydraulicking	5,000,000

For special account of yield per running foot of channel, and per ton of gravel, see tabular statement.

The richest drifting channel on the divide was, doubtless, the Forest Hill channel, or series of parallel narrow courses under the town of Forest Hill, which, according to hearsay, yielded by drifting an average exceeding $1,000 per running foot.

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to the main tunnel, and run thence by gravity to the dump house on the surface. One horse hauls a train of eleven empty cars into the mine.

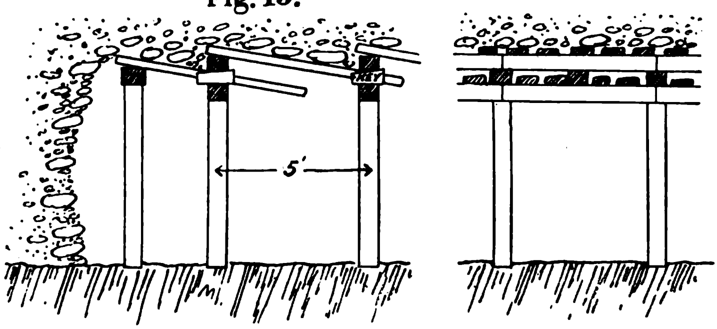
Car Track, steel rails, thirty pounds per yard length.

Tunnel Timbering.—The pressure from the gravel is not great, but the swelling bedrock has been a source of trouble, driving the legs of the timber-set inward and crushing the cap. After many unsuccessful attempts to overcome this difficulty, the legs were given an increasingly greater bottom-spread, until finally it was found that they remained stationary. The swelling bedrock is removed from time to time and the track adjusted. The accompanying cut shows the form of tunnel timber-set now used in bad swelling ground. (See Fig. 14.)

Sets are first put in four feet apart, and in the course of a few months center-sets are placed between these. Timber-sets on this plan have now been in place three years and are still in good condition. In the eight thousand five hundred feet length of tunnel, there are about four thousand sets of timbers. Two men are kept constantly employed in easing and repairing the sets and adjusting the track.

Breast Timbering.—In breasting the loose gravel the ground is timbered closely as shown in sketch (Fig. 15).

Fig. 15.



The excavation is partly filled in or walled up with large bowlders to prevent extensive caving.

Powder, used only in small quantity in taking up bedrock and breaking large bowlders; total quantity about three thousand pounds No. 2 dynamite per annum.

Ventilation.—An air drift is run in the gravel, following the tunnel. By means of connecting drifts between tunnel and air drift, and with the assistance of a small furnace in the tunnel, a good circulation of air is maintained. There being very little powder used in the mine, this method of ventilating answers fairly well.

Washing the Gravel.—Storage capacity of dumping floor, four hundred tons. Size of nozzle, three inches. Water pressure at the nozzle, sixteen feet. The sluice boxes are eighteen inches wide and twelve feet long, and have a grade of eighteen inches to the box for the first six hundred and eighty-five feet, and twenty inches to the box thereafter.

The line of sluices is as follows, beginning at the dumping floor: One box Hungarian riffles; one hundred and ten feet flat and car-wheel riffles; eight hundred and seventy-two feet rock riffles, with occasional Hungarian riffles; grizzly and undercurrent with fall of fifteen feet; one

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hundred and forty-four feet rock riffles; drop of sixteen feet; one hundred and six feet car-wheel riffles; tailings accumulate in cañon below. All but the Hungarian riffles are more or less charged with quicksilver.

Clean-up.—The upper box of Hungarian riffles is cleaned up daily; the one hundred and ten feet of flat riffles and car-wheels once in two to four weeks; the remaining riffles four times per annum. The tailings in the cañon are sold to the highest bidder.

During the year 1889, under the management of Mr. Power, the total expense of the mine, or the difference between production and dividend, was 99 cents per ton of gravel washed.

For further details, see map and tabular statements.

MAY FLOWER.

Mine opened and worked by F. Chappellet, as Superintendent, for the May Flower Gravel Mining Company, of San Francisco.

Pay Channel fairly uniform in course, though irregular in grade and pay.

Gravel, hard cemented, involving the use of a large quantity of powder in breaking, and a small expense in timbering. Requires milling.

Bedrock, hard slate, requiring considerable powder in blasting, but no timbering.

Method of Attack.—The channel is reached through four thousand six hundred and forty feet of straight bedrock tunnel (with uniform grade of three inches in one hundred feet), seven hundred and sixty-five feet of incline (with up-grade of eight in one hundred), and a bedrock gangway under the channel with twenty to forty feet upraises to the channel bottom. Present distance trammed from gravel breast to mill, eight thousand five hundred feet. The gravel is breasted by drilling and blasting, and is shoveled into small cars having a capacity of one thousand three hundred pounds each. The cars are pushed by hand to a chute. Larger cars, having a capacity of one ton each, are loaded at the chute and pushed by hand through the bedrock gangway to the head of the incline, and from the foot of the incline are hauled by mules to the mill dump on the surface. At the incline the empty cars are lifted by the loaded. One small mule will haul ten or twelve empty cars into or loaded cars out of the tunnel, with about the same facility.

Car Track, steel rails, sixteen pounds per yard length.

Bedrock Gangway.—Size, seven feet by seven feet. The channel rises and falls alternately, sometimes ten or fifteen feet in a length of three or four hundred. There is, in places, considerable water in the gravel. Owing to these conditions the driving of the bedrock gangway, even though a matter of large expense, is essential to the successful working of the mine. There are two gangways, one following the channel up stream, one down stream. In order to push these ahead fast enough to keep pace with breasting, a compressor plant is maintained to drive air drills. Two air drills are run in the face. Blasting with No. 1 and No. 2 dynamite powder. Very little timbering. Expense of gangway, about $13 per foot length. Progress, from one hundred to two hundred and fifty feet per month, as required.

Compressor Plant, located at mouth of tunnel. One boiler forty-four inches by twelve feet; one boiler fifty-four inches by fourteen feet.

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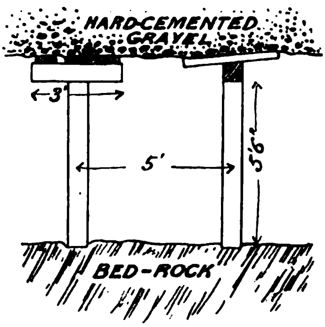
Two Burleigh compressors, eighteen-inch cylinders, twenty-inch stroke. One five-foot Pelton waterwheel to run one compressor during winter and spring. Compressed air pipe six inches, four inches, and two inches. Three air receivers thirty-six inches by twelve feet—one in compressor-room, one halfway in tunnel, one at head of incline. Two three-inch Ingersoll air drills, and four three and one half inch.

Fig. 16.



Gravel Breasting.—Drilling single-handed. Blasting with No. 2 dynamite powder. Timbering with short caps and posts five or six feet apart. (See Fig. 16.)

Excavation in great part filled in with bowlders. A gravel breast, seventy-five feet wide and six feet high, is driven ahead along the length of the channel at the rate of eighty to ninety feet per month, and there are required two such breasts to keep the twenty-stamp mill running at full capacity. Prospect drifts, in gravel, cost $2 50 to $3 per foot length.

Powder.—The amounts of dynamite powder consumed are as follows: In bedrock gangway, four pounds of No. 1 and four pounds of No. 2 per foot of length, at cost of $1 70. In gravel breast, one half pound of No. 2 per ton of gravel delivered, at cost of 8 cents. Total quantity, about thirty-five thousand pounds per annum.

Ventilation.—In part by compressed air, in part by connection with air shaft.

Gravel Mill.—Twenty-stamp mill located at mouth of tunnel. Four batteries of five stamps each. Stamp, eight hundred and fifty pounds; seven and a half inches drop; one hundred drops per minute. To each battery there is an automatic feeder (Challenge), a grooved wooden table, an oscillating rubber (Eureka), and a box of riffles. For screens, punched iron plates are used, two tenths inch holes, six or seven holes to the square inch.

The mill is run by steam power in the summer and fall, and by water power in the winter and spring. There are provided for this purpose one boiler, forty-eight inches by sixteen feet; one engine of seventy-five horse-power; one five-foot Pelton waterwheel.

Amalgamating plates have been discarded. The horizontal grooves across the table are one and one half inches wide, three fourths of an inch deep, and about twenty inches apart. The mortars and grooves are charged with quicksilver.

The gravel, as it enters the feeders, is picked over by two assorters, who throw out the large clean pebbles and bowlders. About 9 per cent of the mass is assorted out in this way and is washed down the sluices without passing through the mill.

The tailings pass through eight hundred feet of sluice boxes.

The stoppages in the mill during a run of one hundred and forty days amounted to ninety-two hours for small repairs and adjustments, and forty-four hours for clean-up—about one hour in twenty-four altogether.

Clean-up.—Upper groove, daily; mortar, two, three, or four times per month; lower grooves and rubber, monthly; tailing sluices, three or four

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times per year. Most of the gold is collected in the mortar and upper groove. (See tabulated statement.) The oscillating rubber collects a certain amount of quicksilver, but its usefulness scarcely appears proportionate to the amount of power absorbed.

For further details, see map and tabular statements.

PARAGON.

Mine worked under joint direction of owners, A. Breece and J. Wheeler. Present Superintendent, W. H. Grenell.

Pay Channels.—A complete cross-section of the channel is exposed by hydraulicking, at a point where the present Volcano Cañon has cut and swept away a great portion of the deposit. The channel is the same as the May Flower. The bottom lead, immediately on the bedrock, and the upper lead, one hundred and fifty feet above, have both been worked. The bottom lead is irregular in pay and very irregular in grade. The upper lead is more regular in grade and pay.

Gravel.—The gravel of the bottom lead is the same in character as in the May Flower, requiring blasting and milling. The gravel of the upper lead is not so strongly cemented, and is breasted by picking, but is nevertheless worked by milling. The width of pay gravel is several times greater in the upper than in the bottom lead.

Bedrock, mostly hard slate, same as in May Flower Mine.

Method of Attack.—The bottom lead is followed direct from the surface exposure into the hill by means of a bedrock tunnel and upraises to the channel bottom. The course of the tunnel is sinuous, and its grade irregular; average, six inches in one hundred feet. Present length from gravel breast to surface, seven thousand six hundred feet. The bottom gravel is breasted by drilling and blasting, and is shoveled into cars and trammed by hand to the chute; thence by hand, in cars of one ton capacity each, to the mill dump on the surface. The upper lead was worked out to a point where it was cut off by a cement channel.

Car Track, mostly of scrap-iron.

Bedrock Tunnel.—Drilling, double-hand. Powder, No. 1 dynamite. Progress, twenty-five to sixty-five feet per month. Cost per foot length, $7 to $12; average, $8.

Gravel Breasting, in bottom lead, same as in May Flower; No. 1 dynamite in bedrock tunnel, and No. 2 in gravel breast.

Ventilation, by means of No. 4 Baker blower, driven by overshot waterwheel at mouth of tunnel. Air pipe, seven inches.

Gravel Mill, located at mouth of tunnel. Same plan as May Flower Mill. Ten stamps. In place of punched plate, a coarse wire screen is used with twenty-five openings to the square inch. Mill runs twelve hours per day, putting through thirty tons of gravel in that time. Power, steam. Fuel per twelve hours, one and a half cords of wood (pine, spruce, and cedar).

Clean-up.—Upper two grooves, daily; mortar, weekly; rubber, two or three times per year; sluices, once or twice per year.

For further details, see map and tabular statements. In the tabular statements, two figures are given regarding length of channel worked and yield. The upper figure is based upon the known yield since March 1, 1866, under ownership of Messrs. Breece & Wheeler; the lower figure is based upon the estimated yield under prior ownership.

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RED POINT.

Mine opened and worked by Charles F. Hoffmann, as Superintendent for the Golden River Mining Company of Paris.

Pay Channel, fairly uniform in general course and grade, though irregular in width and depth of gravel and in pay.

Gravel, cemented, though not so hard as that of the bottom lead of the May Flower and Paragon, involving the use of a large amount of powder in breaking, and a small expense in timbering. Gravel worked by washing, though not so free as Hidden Treasure gravel.

Method of Attack.—The channel is reached through two thousand feet of bedrock tunnel, and upraises twenty to forty feet to channel bottom. Grade of tunnel, uniformly three inches in one hundred feet. Present distance trammed from gravel breast to washing floor on surface, four thousand feet. The gravel is breasted by drilling and blasting, and is shoveled into cars and pushed by hand to the chute. Cars having a capacity of one ton each are loaded at the chute and hauled by horses to the washing floor at the mouth of the tunnel.

Car Track, steel rails, sixteen pounds per yard length.

Bedrock Tunnel.—Size, seven feet by eight feet. In order to push the tunnel ahead rapidly, a compressor plant is maintained to drive air drills. Two air drills are run in the face. Blasting, with No. 2 dynamite powder. Very little timbering. Mr. Hoffmann has prepared a tabular statement showing the cost of labor and supplies per foot length of tunnel, from which the following is extracted:

Cost per Running Foot of Tunnel.

Labor	$7 35
Powder	1 70
Fuse and caps	17
Wood	71
Charcoal	21
Candles	19
Foot-planks and ties	09
Timbers for about 10 per cent of length	03
Steel rails	33
Air and water pipes	35
Horse feed	18
Oil and tools	45
Freight	64
Total, exclusive of management	$12 40

Average progress, about two hundred and fifty feet per month when required.

Compressor Plant, located on a flat, about two hundred feet above, and three hundred feet distant from the mouth of the tunnel. One boiler fifty-four inches by sixteen feet. One Ingersoll straight-line compressor, sixteen inches by twenty-four inches. Three three and one half-inch Eclipse air drills. Compressed air-pipe, three inch. The plant is well adapted for the purpose of tunneling. Cost, including substantial building, etc., about $8,000. When running bedrock tunnel with two drills, the consumption of fuel is two and one half cords of wood (mixed pine, spruce, and cedar).

Gravel Breasting.—Usually the entire body of gravel is breasted from bedrock to volcanic cement, the latter forming a clear roof to work to. Drilling, single-hand. Blasting with No. 2 dynamite powder. The

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method of timbering is the same as in the May Flower. Sets six or seven feet apart. Where the gravel is deep and the pay does not warrant the removal of the entire quantity, the timber is closer and heavier, to prevent the upper layer of gravel from flaking or slipping at the contact-surface with cement.

Powder, used in large quantities, both in driving the bedrock tunnel and in breasting the gravel. The amount used in the bedrock tunnel may be figured from the table above. The amount used in the work in the channel is one half pound per ton of gravel delivered; cost, 8 cents.

Ventilation.—No. 4 Baker blower run by small steam engine in compressor building. Air-pipe, eleven inches; cost, 45 cents per foot.

Washing the Gravel.—Length of dump house, fifty feet. Depth from car track (tunnel level) to washing floor, thirty feet. Storage capacity, four hundred tons. Size of nozzle, three inches. Water pressure at the nozzle, twenty-five feet. The sluice boxes are eighteen inches wide and twelve feet long, and have a grade of eighteen inches to the box.

The line of sluices is as follows, beginning at the dumping or washing floor: Two hundred feet Hungarian and flat riffles; drop, thirty feet; twenty-four feet wooden block and rock riffles; sixty-five feet ground sluice; one hundred and forty feet block, rock, flat, and Hungarian riffles; six hundred and eighty feet cañon bed; drop, twenty feet; seventy-five feet ground sluices; drop, six feet; forty feet ground sluices; eighty feet twenty-four-inch flume; three hundred feet ground sluices; dam; forty feet double thirty-inch flume; grizzly and undercurrent, with fall of fifteen feet; tailings accumulate in cañon below.

The lower riffles are charged with quicksilver.

Clean-up.—The upper four boxes are cleaned up two or three times per week; the following three hundred and forty feet of riffles, once a month; the balance four or five times a year. The tailings in the cañon are sold to the highest bidder.

The total cost of surface plant and improvements, including compressor plant, boarding house, office, and dwelling, blacksmith shop, stable, powder house, wood shed, framing shed, snow sheds, one and one half miles of graded wagon road, trails, graded yard, dump house, tank, sluices, one and one half miles of seven-inch pipe for water supply, four horses, etc., about $22,000.

For further details, see map and tabular statements; also, article by Charles F. Hoffmann, published in the "Mining and Industrial Advocate" of San Francisco, March 10, 1887; also, R. L. Dunn's article in annual report of State Mineralogist, 1888.

The following tabular statement gives in round numbers the results of the working of the four mines:

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TABULAR STATEMENT.

	Hidden Treasure.	May Flower.	Paragon.	Red Point.
1. Character of pay gravel—Bottom lead	Loose	Hard cemented	Hard cemented	Med. cemented.
Upper lead	Not known	Known, but not worked.	Slightly cemented	Not known.
2. Material of pebbles and bowlders predominating—Bottom lead	Quartz	Metamorphic rocks.	Metamorphic rocks.	Metamorphic rocks.*
Upper lead			Quartz	
3. Color of pay gravel—Bottom lead	White; red	Gray; blue	Gray; blue	Gray; blue.
Upper lead			Red	
4. Material immediately overlying pay gravel—Bottom lead	Loose gravel and sand.	Cemented gravel and sand.	Cemented gravel and sand.	Volcanic cement.
Upper lead			Gray sand	
5. Average width of gravel breasted, feet—Bottom lead	250	75	50	120
Upper lead			225	
6. Depth of gravel breasted, feet—Bottom lead	4 to 7	2 to 14	2 to 7	2 to 12
Upper lead			5	
7. Portion of gravel breasted, consisting of large bowlders, and left in mine, per cent—Bottom lead	25	35	25	30
Upper lead			20	
8. Total length of channel worked, feet—Bottom lead	7,700	3,900	5,400; 1,400	2,300
Upper lead			2,000; 1,000	
9. Portion of this length yielding pay, per cent—Bottom lead	100	66	66	66
Upper lead			75	
10. Average fall of channel, feet per mile—Bottom lead	70	60	Uncertain	75
11. Manner of breasting—Bottom lead	Picking and caving.	Drilling and blasting.	Drilling and blasting.	Drilling and blasting.
Upper lead			Picking	
12. Manner of extracting gold from gravel—Bottom lead	Sluicing	Milling	Milling	Sluicing.
Upper lead			Milling	
13. Number of tons of gravel delivered per 24 hours, during active operation upon average gravel breast—Bottom lead	275	130	30	100
14. Number of men employed in the mine and on the surface, during active operation upon average gravel breast—White men	35	85	27	25
Chinamen	85	45		25
15. Average daily wages per man	$2 15	$2 75	$2 70	$2 40
16. Average cost of labor and supplies in mining and milling, or sluicing, per ton of gravel delivered, during active operation upon average gravel breast, not including management, improvements, additions to plant, nor deadwork during periods of non-production	$1 10†	$8 25	$8 25	$2

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17. Total gross yield to date, August, 1890—By drifting bottom lead	$1,150,000	$585,000	$675,000; $175,000	$150,000
By drifting upper lead			$600,000; $300,000	
By hydraulicking			$245,000; $255,000	
18. Dividends‡	$340,000		$600,000	
19. Average gross yield per linear foot of channel—Bottom lead	$150	$150	$125	$70
Upper lead			$300	
20. Average gross yield per ton of gravel delivered to surface—Bottom lead	$1 75	$7	$10	$2 50
Upper lead			$4 50	

* In these gravels there occur a number of pebbles of granitic and porphyritic rocks, but apparently none of volcanic rocks so recent as the earliest known volcanic caps in the district.

† In case of the Hidden Treasure, the figure given ($1 10) includes the management. The periods of non-production, and the improvements or additions to plant, were comparatively small.

‡ In the May Flower Mine large expenditures were made before the deep channel was discovered, and after finding the channel a large amount of deadwork was involved in the running of the deep drain tunnel, etc. The production has been taxed with the payment of purchase money for adjoining claims. For these reasons the yield has not, as yet, nearly reached the total amount of expenditures.

In the Red Point Mine considerable deadwork was done before developing the channel, and after the development a portion of the production was taxed for improvements. The yield has not, as yet, nearly reached the total amount of the expenditures.

The channels of the Hidden Treasure and Paragon, on the other hand, were exposed near the surface, and attacked with little preliminary expense, hence these were dividend-paying mines almost from the start.

In the Hidden Treasure, the channel has been worked for about fifteen years; in the Paragon, twenty-eight years; in the May Flower and Red Point, about two and a half years.

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Men Employed during Active Operation upon Average Gravel Breast.

	Hiddden Treasure.	May Flower.	Paragon.	Red Point.
Clerk	1	1		
Mine foremen	2	1	1	1
Mill and outside foreman		1		
Compressor engineers		2		2
Mill engineers		2	1	
Blacksmiths	3	2	1	1
Blacksmith helpers	1	2		
Carpenters	1	2		
Timbermen and rock-pilers	12			
Track men	2			
Shift bosses		4	1	2
Gravel washers	1			
Miners in tunnel or gangway	12	12	4	7
Miners in gravel breast	86	44	16	28
Shovelers, carmen, etc.		42		6
Drivers	2	2		2
Dumpers	2	2		
Teamsters		2		
Outside laborers	1	3	1	1
Mill hands—amalgamators		2	1	
Mill hands—assorters		4	1	
Total number, excluding management	126	130	27	50

Milling and Sluicing Returns.

	Hidden Treasure.	May Flower.	Paragon.	Red Point.
1. Manner of extracting gold from gravel	Sluicing.	Milling	Milling	Sluicing.
2. Number of stamps in mill		20	10	
3. Loss of weight in melting bullion, per cent	1.43	1.60	1.25	2.08
4. Fineness of bullion after melting	0.928	0.880	0.870	0.931
5. Per cent of total production obtained:				
From upper box, 12 feet	80			
From upper four boxes, 48 feet				85
From remaining sluices	18			13
From sale of tailings	2			2
	100			100
From mortars		66.	75.	
From upper grooves		32.	24.	
From lower grooves, rubbish boxes		1.5	0.75	
From tailing sluice		0.5	0.25	
		100.	100.	
6. Number of tons of gravel milled per stamp per 24 hours		6.5	6.0	
7. Number of cubic feet of water used for washing or milling per ton of gravel	(?)	325	325	175
8. Portion of pound of quicksilver lost per ton of gravel	0.003	0.1	(?)	0.003
9. Cost of milling per ton of gravel:				
By water power		$0 25		
By steam power		0 35	$0 50	

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THE MAP.

The accompanying map and sections present the results of the writer's surveys and examinations during the past five years. The northeasterly portion of the work was conducted for the benefit of the Golden River Mining Company, under the direction of Mr. Geo. De la Bouglise and Mr. Chas. F. Hoffmann; in part, also, for the McIntyre Mining Company. The southwesterly portion, in part for Messrs. Renevey and De la Bouglise, in part for various mining companies.

A large portion of the underground information of the Bath, Forest Hill, and lower districts, is based upon the surveys of Mr. Anthony Clark, who generously furnished a large amount of information, the accumulation of thirty years.

The central portion of the work was conducted during the past year for the special purpose of the present report to the State Mineralogist. The map was drawn by Mr. John D. Hoffmann.

The location of the points shown was obtained by a network of needle-traverse lines run with transit and telemeter. Numerous barometric readings were taken between Forest Hill and Colfax during the past five years, and the elevation above sea level thus obtained is the basis of all elevations given on the map. The differences of level were determined either with the leveling instrument or the transit and telemeter.

The location of the contact lines between the bedrock and the volcanic cap, or river deposit, represents a continuous traverse line. In certain sections where the soil is deep and there are no developments, this line could not be determined satisfactorily, but on the whole it is believed to be fairly correct.

The underground developments, where they were readily accessible and had not been previously surveyed, were specially surveyed for the purposes of the examination and map.

The sections on the sheet are generally based upon definite information wherever the lines are given in full, and the bedrock is shaded with black lines. The dotted lines are conjectural.

The marking of the channel courses upon the map is very incomplete. Where the connection of two or more developments is indicated by the coloring, the data is reasonably satisfactory, though the course is subject to a certain amount of variation.

The development of the white channel in the Mountain Gate and Hidden Treasure Mines leaves no doubt of its continuity. Patches of this channel are left at Gas Hill and at Michigan Bluff. What becomes of the channel beyond this point, or what connection it has with the channels of the Forest Hill section, is a matter of conjecture.

The Paragon channel is shown as passing through the May Flower, Excelsior, Baltimore, and Dardanelles Claims. In the writer's mind the evidence is strongly in favor of such a course. What becomes of the channel beyond the Dardanelles is not known; probably a considerable portion of it was obliterated by the deeper cement channel.

In the upper or northeasterly third of the district covered by the map, between the Hogsback and Black Cañon sections at one end, and the Red Point, Dam, and Dix sections at the other end, there is no development of the bottoms of the deep channels, and it is impossible to

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Breece & Wheeler Ditch—below Baker Ranch	3,633
Volcano Cañon Crossing	3,663
Above Michigan Bluff	3,710
At Sunny South	3,775
At Dam Mine	3,832
At Rainbow Mine	3,902
Buzzard's saloon	2,406
Centennial slope—top	2,557
Bottom	(2,461)
Tunnel	2,518
Chicken Hawk—bridge across Volcano Cañon	4,217
Chrome pile	3,718
Clara tunnel	4,212
Colfax tunnel	3,656
Dardanelles tunnel	2,603
Dam tunnel	3,718
Damascus Hotel	4,020
Eureka—lower tunnel	(4,344)
Upper tunnel (Haney's)	4,454
Excelsior shaft—top	3,032
Bedrock in bottom	2,840
Excelsior slope—bedrock in bottom	2,701
Forest Hill—Forest House	3,246
Forks House	4,790
Gas Hill—bedrock	3,554
Georgia Consolidated shaft—top	3,947
Georgia Hill—bedrock	2,576
Giant Gap—upper tunnel	3,796
Lower tunnel	3,509
Golden Fleece tunnel	4,793
Golden River—see Red Point.	
Gray Eagle shaft—top	2,699
Hazard shaft—top	3,288
Bedrock in bottom	(3,156)
Hermit tunnel	3,513
Hidden Treasure tunnel	3,644
Hogsback—upper tunnel	4,841
Middle tunnel	(4,761)
Lower tunnel	(4,324)
Independent slope—top	3,129
Indian Springs Hotel (Westville)	5,248
Iowa Hill Canal—at Tadpole	5,360
At Hogsback	5,338
At China Wall	5,044
At Giant Gap	4,000
At Jimtown	4,020
Jimtown shaft—top	3,921
Bottom	(3,814)
Kirk's tunnel	2,923
Laus Ranch	3,869
Lewis—Bob Lewis tunnel	3,836
Live Oak tunnel	2,657
Macedon tunnel	5,014
Maintop Hotel (Haney's)	4,458
Maus tunnel	3,024
May Flower tunnel	2,685
May Flower channel—bedrock north	2,805
Bedrock south	2,755
McIntyre tunnel	3,784
Michigan Bluff—Powell Hotel	3,505
Miner's ditch—above Excelsior shaft	3,071
At May Flower Ravine	3,175
On Kirk's Point	3,256
At Shirt-tail reservoir	3,376
Missouri tunnel	2,607
Mitchell tunnel	3,694
Mountain Chief slope—top	4,103
Bottom	(3,765)
Mountain Gate—main tunnel	3,754
Mountain Gate—bedrock, white channel	3,944
Bedrock, blue channel	3,754
Mountain tunnel	2,679
Top of shaft	2,872
Muir tunnel (Michigan Bluff)	3,180
New Jersey tunnel	2,859
New Jersey air shaft, top	3,233

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New Union ditch—at Pacific Cañon	3,046
At Black Hawk Cañon	3,064
On Kirk's Point	3,087
North Star barn	2,762
North Star tunnel	2,544
Old Union ditch—at Third Brushy Cañon	2,810
Oro tunnel	3,488
Orono tunnel	3,017
Owl Creek lower tunnel	2,478
Paragon—Breece & Wheeler tunnel	2,853
Top of air shaft	3,509
Pond ditch—in Forest Hill	3,192
At Bath	3,235
At Volcano Cañon	3,280
Pond hydraulic pit—lowest bedrock	2,728
Rainbow tunnel	3,698
Red Point (Golden River) tunnel	3,827
Bedrock of channel	3,860
Red Sea tunnel	2,578
Rough and Ready tunnel	2,199
Sacramento tunnel	2,587
San Francisco tunnel	2,718
Scott's tunnel (Volcano Claim)	3,054
Sebastopol—lower tunnel	2,953
Secret House	5,443
Sellier shaft—top	4,323
Small Hope tunnel	2,706
Spring Garden slope—top	2,429
St. George tunnel	2,606
Sugar Pine Sawmill—boarding house	4,034
Swift Shore tunnel	3,500
Todd's Valley bridge	2,664
Union Tunnel—Peckham Hill	2,062
Washington shaft—top	3,307
Wason tunnel	3,000
Weske tunnel	3,363
Westchester slope—top	2,868
Wolverine tunnel	2,439
Yankee Jims—Duncan's saloon	2,603
Channel	2,630

The above altitudes are thought to be relatively correct within ten feet.

APPENDIX A.

The Hidden Treasure, Paragon, Pond, and Yankee Jim channels are all indicated on the map as belonging to the first period. It is plain that if these were the channels of running streams at the same time, they must have been forks of one and the same river. But this appears very unlikely. The gravel of the Hidden Treasure differs so greatly in character from that of the Paragon, that it is difficult to imagine the former merging into the latter in a distance of a few miles only. Furthermore, the Hidden Treasure and Pond channels are apparently higher in level than the Paragon and Yankee Jim channels.

The information points to the conclusion that these four channels were formed and filled with large accumulations of gravel prior to the first important flow of volcanic cement in the district described. There is, however, no exposure of an intersection or of a juncture of any two of them, and the writer is wholly in doubt with regard to their relation.

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APPENDIX B.

That the Mountain Gate "blue channel" belongs to the second period is inferred, but not as yet established by direct evidence. The gravel contains pebbles of porphyritic rocks, but, as far as learned, none of volcanic rocks so recent as the immediate cap of the white channel which it cuts. This is not surprising, as the first cement cap of the earlier system is, as far as the writer has observed, fine grained and too loose to form pebbles. The cements containing fragments and bowlders of lava were first introduced as a capping of the gravel deposits of this blue channel. The volcanic gravel was of a later origin, resulting doubtless from the erosion of the cap. There is wanting in this section an exposure to show the cutting of the light cement cap of the earlier system, to establish conclusively that the formation of this blue channel was due to a diversion of the stream, caused by a cement flow.

That the volcanic gravel channel belongs to the second period is directly shown by the character of the gravel.

The longitudinal section of the Weske (see Fig. 6) and Paragon channels (see map) furnish more definite evidence of the existence of at least two deep channel systems belonging to the second period. The cross channel, cutting both the gravel deposit and the white cement cap of the Paragon and the May Flower, belongs to a system earlier than the volcanic-gravel channel.

Just how many channel systems of the second period are represented by the various patches exposed it is difficult to say. Two such are virtually established, and one more is less satisfactorily indicated.

It is practically shown that during comparatively recent geological epochs, the streams of the district have cut their channels at least three or four times to a depth of several hundred or a thousand feet, and once to a depth of three thousand feet.

APPENDIX C.

In the hydraulic pit of the Dardanelles Mine there is exposed a long fissure crossing the channel, and apparently faulting the bed to a slight extent. The strike is about south 75 degrees west magnetic, and the pitch steep to the north. The fissure is crossed by the bedrock tunnel, and is filled at that point with a fine, light gray sediment, apparently of volcanic origin and inclosing seams and bunches of quartz. The ledge, thus constituted, is said to have passed entirely through the gravel but not into the volcanic cement cap. A portion of this cement cap is similar in appearance to the filling of the fissure below, but coarser and more granular in structure. The gravel is washed away by hydraulicking, and there is no opportunity of verifying the statements made with regard to it.

It appears not unlikely that the formation of this fissure was directly due to the volcanic activity which led to the first important flow of cement.

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Cost of freight from railroad to mine	1 cent per pound.
Cost of freight from San Francisco to railroad	2 cents per pound.
Course of vein	Northeast.
Direction of dip of vein	West.
Average width of vein	3 feet, and 1½ to 2 feet.
Formation of walls	Slate.
Tunnel or shaft	Both.
Number of tunnels	1 on each claim.
Length of tunnel No. 1	200 feet.
Length of tunnel No. 2	200 feet.
Cost per foot running tunnel	$7 50 and $8.
Vertical depth reached in tunnel	No. 1, 80 feet; No. 2, 90 feet.
Length of tunnel timbered	Entire length.
Dimensions of tunnel	6 feet by 4 feet.
Formation passed through	Slate.
Number of feet run per shift	No. 1, 1½ feet; No. 2, 1 foot.
Length of ore shoots	No. 1, 130 feet; No. 2, 200 feet; end not yet reached.
Greatest length of ground stoped	No. 1, 130 feet; No. 2, 20 feet.
Pitch of ore shoot	North.
Kind of timber used in mine	Sugar pine, round.
Cost of timber	3 cents per running foot.
Shafts, vertical or incline	Vertical.
Depth reached, in feet	No. 1, 80 feet; No. 2, 90 feet.
Kind of pump used	Cornish plunger.
Kind of drill used	Hand drill.
Kind of powder used	Giant No. 1.
Quantity of powder used	100 pounds per annum.
Quantity of steel used for drills	100 pounds.
Cost of mining per ton of ore	$2 50 per ton.
Dimensions of shaft	6 feet by 6 feet.
Number of feet sunk per shift	1 foot.
Formation passed through	Granite and slate.
Distance from mine to timber	On the ground.
Source of timber	Government land.
Cost of timber	3 cents per foot.
Distance from mine to lumber	10 miles.
Cost of lumber	$15 per thousand.
Length of road built by company	10 miles.
Cost of road	$20 per mile.
Length of ditch built by company	1½ miles.
Cost of ditch	$1 50 per rod.
Means of transporting ore to works	Wagons.
Cost of transporting ore to works	50 cents per ton.
Character of ore	Gold quartz with sulphurets.
Method of treating ore	Amalgamation in battery.
Description of mill or works	5-stamp water mill.
Number of stamps	5.
Weight of stamps	650 pounds.
Drop of stamps	6 inches.
Drops per minute	72.
Height of discharge	6 inches.
Duty per stamp in twenty-four hours	Three quarters of a ton.
Kind of metal used for shoes and dies	Common white iron.
Cost of shoes and dies per pound	8 cents per pound.
Wear of shoes and dies per ton crushed	250 tons with 1 set.
Battery screens, number	Slot-punched No. 11.
Dimensions of screens inside of frame	10 inches by 40 inches.
Vertical or inclined	Inclined.
Size of apron plates	4 feet by 6 feet.
Size of plates inside of battery	10 inches by 4 feet.
Copper or silvered plates	Silvered.
Inclination of plates	1¼ inches to the foot.
Kind of feeders used	Hendy Challenge.
Percentage of value saved in battery	50 per cent.
Percentage of value saved on plates	50 per cent.
Percentage of sulphurets	1 per cent.
Nature of sulphurets	Iron.
Method of saving sulphurets	On blankets.
Number of men employed in mine	4.
Number of men employed in mill	2.
Number of men employed on outside	2.
Total number employed	8.
Nationality	Caucasian.
Average wages paid per day in mine	$1 50 and board.
Average wages paid per day in mill	$2 00 and board.
Average wages paid per day on outside work	$1 50 and board.

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Water or steam power ..Hurdy wheel, 6 feet diameter, 150 feet head, through 1⅛-inch nozzle and 8-inch pipe.
Wood used per day........1½ cords of 2-foot wood.
Species of wood........Yellow pine.
Cost of wood per cord........$1 50.
Cost of water........Owned by company.

The company intend to sink the shaft on No. 2 fifty feet deeper, and drive tunnels at that depth, and stope.

Indian Valley is about ten miles long, and is surrounded on all sides by wooded hills, those on the east side rising to a height of six thousand feet. It comprises an area of about forty-seven thousand acres. On the south side of the valley is Hough's Peak, a prominent eruptive mass that overlooks the entire valley. Behind this peak is a small lake known as Gem Lake, about one and one half miles long by one mile wide, having an altitude of seven thousand four hundred and thirty feet. It has all the appearance of having been an old crater, and it is reported that in places it has not been bottomed. At the foot of the bluff on the level of the valley, years ago were two large mining properties, with a large steam mill. Too much stock-jobbing killed them effectually; and although they had yielded quite a large amount of bullion, the mill and works were removed, and to-day the sites of the mines are overgrown with a heavy growth of young timber. To the south and west is a range that forms the dividing boundary between Indian Valley and Round Valley, and extends from the village of Crescent Mills to the village of Greenville, in the western corner of Indian Valley. This small range (it is not over six miles long) contains a great amount of mines and prospects, some of which are of considerable extent. The first one is partly in the valley.

THE CRESCENT MINE.

It was partly described in the 1888 report of California State Mining Bureau. Since then, under the careful management of Superintendent Whitney, the underground works have been considerably extended; power drills have been applied, which permit of a larger quartz yield at a reduced expenditure; the company has bought the farm land lying between the mine and the river to quiet any trouble about tailings; and is slowly and systematically developing into a paying property one of those large quartz bodies of low degree, which are a characteristic of this section of country, and which, if supplied with the proper plant and in the hands of the right kind of men, make lasting dividend-paying mines. A shining example of this style of mine and mining is furnished by the Plumas Eureka Mine in this county.

As the notes on the Crescent Mine were only partially given in the report two years ago, they are appended here in a more complete form:

When located........30 years ago.
Dimensions of claim........1,500 feet by 800 feet.
Mining district........Cherokee.
Name of nearest town........Crescent Mills, on property.
Direction and distance to railroad........Southeast, about 40 miles.
Cost of freight from railroad to mine........75 cents to $1 per 100 pounds.
Cost of freight from San Francisco to railroad station........1 cent per pound.
Course of veins........Horseshoe vein, west 20 degrees north; Pet vein, east and west; Crescent vein, east and west.
Direction of dip of veins...Horseshoe vein, south; Pet vein, north; Crescent vein, north.
Degrees of dip of veins........Horseshoe vein, 72 degrees; Pet vein, vertical; Crescent vein, 72 degrees.

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kept in condition. Tunnel No. 3 is one thousand five hundred feet in length; No. 4 is three thousand feet; No. 5, four thousand eight hundred feet; and No. 6, six thousand and seventy-five feet. Three pay shoots have been developed and partly stoped from the fifth level to the surface, but from the sixth up very little has been done.

Adjoining the Green Mountain property over the divide to the west is a very promising mine known as

THE ALTOONA MINE.

It is situated on both sides of the divide that separates Round Valley from Indian Valley, the larger portion on the Round Valley side in Sec. 23, T. 36 N., R. 9 E., M. D. M. Tunnels are run in from both sides, with about three hundred feet of ground unexplored between the breast of the two tunnels. The one from the west is about one hundred and fifty feet deeper than that from the east, and shows in the end a fine vein of quartz four feet wide. It lies between granite and trap rock, the foot wall being granite. It is one and one half miles southwest from the town of Crescent Mills, and is fifteen hundred by five hundred feet. The accompanying plan shows the relative position of the three last mentioned properties, as also of the Round Valley Reservoir, which will be mentioned farther on, and which is likely to be brought in connection with the two last mentioned properties. The vein in the Altoona Mine courses south 65 degrees east for a distance of eight hundred feet, and then south 54 degrees east, and dips northwest about 60 degrees. The pay shoot has been undercut for a distance of seventy feet. The tunnels are, respectively, three hundred feet and four hundred feet long, and attain vertical depths of seventy-five feet and one hundred and fifty feet from the surface. Not more than one half miner's inch of water is made by the mine. The rock and ore are easily broken. In running the tunnel two men can make two feet per shift at a cost of $2 per foot. It costs about $1 50 to put one ton of pay on the dump. The company have their ore worked in a custom mill, but contemplate the erection of a mill of their own if the property is not sold; at present it is under a bond.

On the northwest of the Green Mountain Mine is the

CAHALAN CLAIM,

A quartz vein coursing north of west nearly perpendicular and having three tunnels driven in on the vein for a length of over five hundred feet, furnishing a depth of over seven hundred feet from the bottom of the lowest level in backs. No stoping has been done. The vein is over twelve feet wide, and the quartz will average between $4 and $5 per ton. A water ditch coming from the Round Valley Reservoir, flanking the range, passes above the claim, on its road to the Green Mountain Mine. This can furnish a head of six hundred feet for a mill plant of the largest kind, and the ore can be run from the mouth of the lower tunnel direct into a mill. The claim is in the midst of a fine belt of timber, and every advantage for working is at hand, yet the property is only worked enough to keep it in repair, the grade of the ore being too low for the owner to expend much money.

From this mine in the same course north of west are contiguous claims that are all on a similar large body of quartz, and are only worked at

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times by prospectors in the hope of finding a pay shoot that will rise above the general average of the quartz. The most developed of these is the

PENNSYLVANIA MINE,

Which is being opened up by two brothers, who go out and work awhile for wages, and then return and expend their money in opening up this part of the large quartz vein.

About one quarter of a mile on the course of the vein, still going northwest, is the

INDIAN VALLEY MINE,

One of the oldest and most thoroughly developed mines in Plumas County. It has two well developed chimneys. The one on the east end has, within the last few years during different sale manipulations, been segregated and forms a separate property now. That part of the lode was opened by a tunnel run to the vein for a distance of nearly two thousand feet. The west end had a shaft sunk over seven hundred feet deep on a short but extremely rich pay shoot. Both chimneys were formerly connected by drifts, but part of the mine has been allowed to cave. A large mill run by water and air compressors for machine drills are among the present plant, but on account of some trouble with the owners of the water, both mine and mill were at a standstill, and the Superintendent and part owner was in San Francisco, so that there was no opportunity to examine the property or get any accurate data. The facts here stated are given from the writer's personal knowledge of the property some ten years previous, when there were nearly one hundred men employed in and around this mine.

Just beyond this mine there is a break in the range known as North Cañon, leading down from Round Valley to the town of Greenville. At the Round Valley end a dam has been thrown across the cañon and the greater part of the valley has been turned into a reservoir, which supplies the mines on the range as far as the Green Mountain with water for motive power. The reservoir covers nine hundred and eighty acres; the water ditch to the Green Mountain is four miles long and has an elevation of six hundred feet above the mill of the latter company, and is high enough above the other mines to give a good working head. Near the head of the cañon are several intrusive dikes of serpentine in the granite. Where the large body of quartz, on whose course the above described mines are situated, crosses the cañon a tunnel has been started into the west bank on a pay shoot and a small five-stamp mill placed at the mouth of the tunnel. The entire work in both mine and mill is done by the three owners. The mine is known as the John Bull.

Above and beyond on the same quartz belt are

THE DRURY AND PACIFIC MINES,

Both being worked by the same parties through one tunnel that has its entrance on the west bank of North Cañon. This tunnel is over nine hundred feet long and gains a depth of two hundred feet beneath the surface. Near the back end of the tunnel, stoping has been done too near the surface. In connection with the mine at present, but not owned by the same parties, is a twenty-stamp quartz mill known as the Kettle

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Mill, situated just below the reservoir dam, and using one hundred and fifty miner's inches of water under an eighty-foot head, through an eighteen-inch iron pipe with one and one half-inch nozzle on a five-foot Pelton wheel.

When located	1884.
Mining district	Cherokee.
Name of nearest town	Greenville.
Direction and distance from town	2 miles west of Greenville.
Vein, course of	10 degrees south of west.
Direction of dip	North.
Degrees of dip	30 degrees.
Average width	2½ to 5 feet.
Dimensions of claim	2 claims; 1,500 feet by 600 feet.
Length of ore shoot	500 feet.
Tunnel or shaft	Tunnel.
Length of tunnel	900 feet.
Vertical depth from surface reached in tunnel	200 feet.
Formation of walls	Decomposed metamorphic.
Quantity of water coming in	1 miner's inch.
Name of drill used	Giant No. 1 and No. 2.
Quantity of powder used	100 pounds per month.
Cost of mining per ton of ore	50 cents per ton.
Cost per foot in running tunnel	$1 50 per foot.
Distance run per day	2 feet.
Formation passed through	Decomposed metamorphic rocks.
Length of tunnel timbered	800 feet.
Kind of timber used	Spruce and pine.
Cost of timber	3 and 3½ cents per foot.
Distance from mine to timber	Found on claim.
Distance from mine to lumber	2 miles.
Length of road built by company	1 mile.
Means of transporting ore to works	Wagon.
Cost of transporting ore to works	33½ cents per ton.
Character of ore	Free-milling gold quartz.
Method of treating ore	Battery amalgamation.
Description of mill	20-stamp water-power mill.
Number of stamps	20.
Weight of stamps	750.
Drop of stamps	5 to 6 inches.
Drops per minute	80.
Duty per stamp in 24 hours	1¾ tons.
Wear of shoes and dies	625 tons for one set.
Kind of metal used for shoes and dies	White iron.
Cost of shoes and dies	5 cents per pound.
Quantity of water used in battery	One half miner's inch.
Battery screens	No. 9 and No. 10 slot-punched.
Dimensions inside of frame	14 inches by 44 inches.
Vertical or inclined	Slightly inclined.
Size of apron plates	5 feet by 4½ feet.
Dimension of plates in sluice	15 inches by 10 feet.
Size of plates inside of battery	6 inches by 44 inches.
Copper or silvered plates	Copper.
Inclination of plates	1 inch in 11 inches.
Kind of feeder used	Hand feeding.
Percentage of value saved in battery	20 per cent.
Percentage of value saved on plates	80 per cent.
Loss of quicksilver	1 tank in 6 months.
Percentage of sulphurets	1 per cent.
Nature of sulphurets	Iron.
Number of men employed in mine	8.
Number of men employed in mill	3.
Number of men employed on outside work	2.
Total number men employed	13.
Average wages paid in mine	$2 75 and $2 50 per day.
Average wages paid in mill	$3 per day.
Average wages paid for outside work	$2 50 per day.
Water or steam power	Water power.
Kind of water motor	5-foot Pelton wheel.
Quantity of water used	150 miner's inches under 6-inch pressure.
Height of fall	80 feet.
Cost of water	50 cents per stamp.

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The developments made consist in driving the tunnel ahead two hundred feet, and in stoping out a distance of sixty feet high and sixty feet long. It is proposed to drive the main tunnel ahead.

ROUND VALLEY CONSOLIDATED MINE,

Like the previously mentioned mines, borders on North Cañon, and is situated in Secs. 10 and 15, T. 26 N., R. 9 E., M. D. M. The course of the vein is 50 degrees south of east, and its dip is nearly perpendicular. The vein is three feet wide, and the walls are apparently a very decomposed trap and granite. The developments consist of three tunnels of the following lengths: No. 1, four hundred feet; No. 2, three hundred feet; and No. 3, one thousand feet; all driven through decomposed trap and granite. No. 1 and No. 2 are stoped out. No. 3 cuts the vein at three hundred feet, at an angle of about 65 degrees. The other two tunnels go in on vein. The ore is crushed in a custom mill.

BLIND LEAD

Six miles southwest of Greenville, on Wolf Creek, is a blanket ledge, which has been taken up lately under the above title. It courses northwest and southeast, and is from six to nine feet thick, dipping very slightly from the horizontal to the north. As far as tested the quartz is worth $6 per ton. The claim has two tunnels, one of one hundred and eighty feet, and the lower one two hundred and thirty feet. The lower tunnel has been started under the vein, and will have to be driven another fifty feet before it will cut the vein; when they reach that point they will have over two hundred feet of the ledge above them. The wall rocks of the vein are serpentine in the foot and clay slate in the hanging. A large body of water was cut in the vein. A ten-stamp steam mill is to be erected soon.

On the north side of Indian Valley some pieces of rich float are occasionally found, but so far no rock in place worth developing has been seen. Back of Taylorville, in the east corner of Indian Valley, are hills of metamorphic rocks, in which some copper veins were developed in former years, but, as the price of copper receded, they were abandoned and have never been reopened. The principal prospect was known as the Montgomery Mine.

Passing from Taylorville up the cañon of the east branch of the North Fork of Feather River, which is known here as Genesee Creek, the south side is bordered by a high ridge, reaching to an altitude of over four thousand feet above sea level, on whose flanks the tracks of landslides and avalanches are plainly marked from top to bottom, and which cause the creek to alternate in its course from side to side. A few miles up the cañon widens, for a distance of about four miles, into a small valley, called Mormon Flat. It is about three quarters of a mile wide, containing slates in the lower end and granite in the upper part, and is of interest as being near the spot where the first fossils were found in California that helped to determine the age of the auriferous slates. This spot was a short distance up a cañon that empties onto Mormon Flat, and the fossils are found in an altered sandstone, fine grained and of a reddish color in places, and has been decided as of Jurassic age. At the head of Mormon Flat the cañon again contracts

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THE OLD NEWTOWN FLAT MINE.

It was located in 1878, contains about three thousand feet of the channel in the claim, and has only been worked on the rim, on account of the large amount of water which the company has not had the means to control successfully. The eighty acres held are patented ground. The channel is an ancient river, with soil capping and free gravel.

When located	1878.
Name of nearest town	Quincy.
Size of claim	80 acres.
Class of deposit	Ancient channel.
Class of bedrock	Slate.
Capping	Soil.
Distance from nearest railroad station	60 miles.
Cost of freight from railroad to mine	1 cent per pound.
Cost of freight from San Francisco to station	1¼ cents per pound.
Depth of deposit, soil	4 feet.
Depth of deposit, gravel	20 feet.
Course of channel	Southeast and northwest.
Worked by tunnel or shaft	Both; at present by shaft.
Cost of tunnel per foot, with track	$5.
Cost of shaft per foot	$5.
Cost of gangways per foot	$6.
How ventilated	Connection of shafts.
Cost of air shaft	$2 per foot.
Width of channel drifts	50 feet.
Depth of gravel drifts	20 feet.
Number of carloads extracted per shift	12, for two men.
Number of shifts per day	2.
Number of men per shift	From 2 to 6.
Kind of drill used	Hand.
Powder used	Giant No. 1.
Amount of powder used per foot of tunnel	1 pound on an average.
Yield of gold per carload of gravel	$2; but the channel ground yields $10.
Weight of carload of gravel	2,500 to 3,000 pounds.
Fineness and value of gold	$18 90 per ounce.
Source of water supply	Plumas Ditch from Spanish Creek, also from the Mountain House.
Cost of water	5 cents per inch for twelve hours.
Length of ditch	30 miles.
Head of water	400 feet.
Length of water season	3½ months; varies with winter.
Number of men in mine	6.
Number of men on outside work	1.
Total men employed	7.
Nationality	Caucasian.
Duty of water in washing	200 carloads with 50 inches.
Kind of timber used	Spruce and yellow pine.
Source of timber supply	On the ground.
Cost of timber as measured	1 cent per foot.
Cost of lagging	2 cents per foot.
Kind of lumber	Yellow pine.
Source of lumber supply	Quincy Sawmill.
Distance to lumber supply	3½ miles.
Cost of lumber as measured	$12 per thousand.
Average wages per month	$50 and board.

THE HUNGARIAN HILL MINES

Have been worked as placer and hydraulic ever since 1857. They are situated on the top of a hill near Quincy on the southwest, about three miles distant, and have yielded large sums of washed gold. Only those parts of the hill that can be profitably worked as drift diggings can be utilized in the future. The hill is slate, which courses 45 degrees west of north, and dips 76 degrees east. The depth of the deposit, which is soil on gravel for a depth of forty-five feet and a width of one hundred feet, has been worked heretofore by hydraulic under a head of one hun-

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day. The mill is supplied with twenty-two Hendy, five Patton, and one Duncan concentrator. Their sulphurets, which average about 1 per cent in the ore, mostly iron sulphurets, with some galena, and which are said to contain $120 per ton in gold, are chlorinated in the company's own works, which were not running during the writer's visit. Numerous arrastras, situated one below the other down the cañon, worked by Italians, take up the tailings and work them over.

The most of the quartz they are crushing at present is supplied from what they term their outside works, which are situated immediately under the peak, over one thousand feet above the level of the mill, and to which it is conveyed on inclined tracks.

On the opposite mountain, but supposed to be on the same vein, is the

LITTLE JAMISON MINE,

Which has been under the ban of litigation for a long time, but is now being put in shape for active and extensive working. It was likewise mentioned in the previous reports.

Eureka Peak is a syenite, with intrusive dikes of serpentine and metamorphic slates. From it, as well as from Mount Elwell, stretch away to the northeast two extensive moraines, and the narrow valley between, in which the town of Johnsville is situated, has been the bed of a glacier coming down from the peaks above. A slide in the moraine on the Eureka side shows the accumulation of large bowlders of different texture very distinctly.

Going up Spanish Creek from Quincy, the road passes along the

PLUMAS WATER AND MINING COMPANY'S PROPERTY,

One of the largest hydraulic properties in the State that has been shut down by law. Over $200,000 have been expended by this company on ditches, flumes, machinery, etc., and a short time ago it was sold, according to the newspapers, for $10,000. Only parts of it are available for drifting purposes.

The company was organized in 1857 and 1858. They take their water from Silver Lake, on Spanish Peak, and bring it through seven miles of ditch to the Mountain House mining camp; there it is dropped through settling dams and brought around to the gravel deposits of Gopher Hill, Badger Hill, and Shore's Hill, and one branch has been taken around to Elizabethtown, making in all twenty-five miles of ditch. The main trunk ditch is sixteen miles long, with a capacity of two thousand two hundred and fifty miner's inches. The Elizabethtown branch is six miles long. There is one mile of pipe, part of it twenty-two inches and part sixteen inches in diameter. Four monitors were in constant use, taking the water under a pressure of from three hundred and fifty to four hundred and seventy-five feet with an eight-inch nozzle. One quarter of a mile was flumed with boxes sixteen inches wide, lined with blocks and riffles, and where going through tunnels with paving. Twenty-five men were employed. The bank averages one hundred feet, and the gravel is from three to six feet deep. The capping is soil and pipe-clay. From two to three tons of Giant powder were required every year to get rid of the pipe-clay, and Chinamen were employed to break up and dispose of the pipe-clay. The gold in the top of the gravel is light; on the bottom

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Cost of mining per ton of ore	$1.
Dimensions of shaft	3 feet by 4 feet.
Distance sunk per shift	3 feet.
Formation passed through	Slate and quartz.
Distance from mine to timber	On the ground.
Cost of timber	2 cents per foot.
Distance from mine to lumber	12 miles.
Cost of lumber	$30 per thousand.
Length of ditch built by company	One half mile.
Cost of ditch	$100.
Character of ore	Quartz and decomposed slate.
Method of treating ore	Washed in sluices.
Number of men in mine	4.
Nationality	Caucasian.
Average wages paid per month in mine	$50 and board.
Average wages paid per month for outside work	$40 and board.
Cost of water	5 cents per inch, under 7-inch head.

During the past year the company has sunk three shafts and run several open cuts on the vein. They propose to continue to drive the tunnel ahead to the big quartz vein, and to erect a mill.

The gold obtained from washing is worth $17 50 per ounce. None of the quartz so far has been tested in a mill. In the slate that lies between the ore vein and the large quartz vein beyond, a distance of fifty feet, there are small stringers of quartz passing from one vein to the other.

Meadow Valley, like Spanish Ranch, lies at the foot of Spanish Peak, at an altitude of three thousand two hundred and fifty feet; the former, however, lies more to the south of the peak. To judge from the configuration of the ground, from observations made, and reliable information furnished on the spot, especially from Mr. Edman, it would appear that what is now Meadow Valley was at one time a lake that has been gradually filled in from slides coming from the main mountain. That the valley is underlaid for the greater part with serpentine may be assumed from the fact of its appearance on both sides of the valley, but although some shafts have been started in the valley itself, nobody, as yet, has reached solid bedrock in the bottom. In the first few feet down a layer of auriferous gravel is encountered, covered with a few inches of soil; this has paid to work in places. It is resting on a false bedrock, below which is dead wash, sand, gravel, etc. This lower gravel has no gold in it, and whenever the hardpan is broken through in sinking the amount of water becomes altogether too heavy to handle. The geology of Spanish Peak is interesting. The main point is granitic, and attains an altitude of six thousand nine hundred and twenty feet; immediately east flanking the granite, and curving around to the south and west, is a belt of slate considerably compressed on the eastern side and approaching near the top at one place; flanking this is a belt of serpentine four miles wide, that reaches from beyond the peak on the north to some distance on the other side of Meadow Valley; this again is bordered on the eastern flank by trap rock. South and slightly west on the main part of the mountain a part of a gravel bed is to be seen; another part of the same bed is found one hundred and twenty feet lower down on the Edman Claim. Passing along the grade that crosses the flank of the peak on the west side north of the road, and about one hundred yards from the road, is a basaltic cone.

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The tunnels are distinguished by names: Eagle Gulch, Arrastra, and Albert tunnels. The ground is extremely heavy to hold up. The timbers are all sawed at the mine; a sawmill and large storehouses, and blacksmith and repair shops are part of the plant of the mine. In the mill is a Huntington rockbreaker. The smaller of the two Huntington mills crushes one thousand three hundred pounds per hour. Four thousand five hundred tons were crushed in one of these mills before it was necessary to change the rings. The water is brought onto the Pelton wheel under a pressure of one hundred and twenty feet, developing thirty-four horse-power with one hundred and fifty inches of water. It is the intention of the company to put in a complete concentration plant as soon as practicable. Of the three claims mentioned in this property and which are worked together and under one management, the Diadem Claim does not belong entirely to the same parties, but they do own nine tenths of it.

Leaving this mine and going westward on the road, the slate country continues until just beyond the divide, which is here five thousand three hundred feet high; then we are on the granite of the peak once more, and find that extending for five miles, when bluish altered slates overlay it. When approaching the Letter Box, or house situated on the dividing ridge between the North and Middle Forks of Feather River, and where the aneroid showed an altitude of five thousand five hundred feet, the formations are entirely granitic, and a depression on the south of this divide, which, with its basin-like form, seems to have been scooped out of the granite by some glacial action, goes by the name of the Granite Basin. Quite a mining camp has gradually developed here, but being in the very heart of the snow belt the effects of the past extremely severe winter had not been effaced; consequently, the writer met only a few of the parties developing mines in this section, as the majority do not spend the winter here, and although it was the latter part of July, they had not yet arrived to repair damages.

From the divide the road descends rapidly into the basin, where five companies are developing mines. Four of these companies have mills—one of twenty stamps, one of ten stamps, and two single battery mills. At the time of the writer's visit, but one of the mills was in actual operation. The ores here near the surface are largely specimen ores. The general system of the veins shows a northwesterly course, with an average width of about two feet, the veins showing a well defined clay gouge. Into this main system numerous feeders coming from the opposite direction terminate. These are small and tight on the walls, and where they strike the main vein, both feeder and main ledge are enriched for a short space; ores that yield up into the hundreds per ton are not unknown. The drainage from the basin is all into the Middle Fork of Feather River.

The first quartz mill that was erected in Plumas County was on a vein of quartz in this basin, operated by Mexicans, and known as the Mexican Mine. It is being worked again at the present day, a tunnel being run to strike under the old pay shoot, two hundred and fifty feet below the surface. Wood and water are abundant in the camp. The chief drawback is the shortness of the working season, snow remaining here long after the surrounding country is clear.

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The tunnels are driven in from the hillside, one under the other. From the upper tunnel, which has a vertical depth of forty feet to the surface, all the ore has been stoped out on the entire distance and clear to the surface. The second tunnel is seventy feet below the first. Between the two is an intermediate tunnel one hundred feet long, that has a short stope connecting with the upper drift. A short stope likewise connects it with the lower tunnel about midway. An upraise at the end of the intermediate drift connects all three.

PAPPIN MINE,

Situated at the lower end of the basin, about three miles from the last described mine, has the most extensive mill plant of any of the mines here.

Elevation above sea level	4,600 feet.
When located	1877.
Dimensions of claim	Two claims, each 1,500 by 600 feet.
Mining district	Granite Basin.
Name of nearest town	Quincy.
Direction and distance from town	East, 26 miles.
Direction and distance from nearest railroad	40 miles southwest.
Cost of freight from railroad to mine	$1\frac{1}{4}$ cents per pound.
Cost of freight from San Francisco to railroad station	Three fourths of a cent per pound.
Course of vein	20 degrees west of north.
Direction of dip of vein	South.
Degrees of dip of vein	80 degrees.
Average width of vein	2 feet.
Formation of hanging wall	Diorite.
Formation of foot wall	Granite.
Number of tunnels	4.
Cost per foot running tunnel	$6.
Vertical depth reached in tunnel	250 feet.
Length of tunnel timbered	One half.
Dimensions of tunnel	4 by 6 feet.
Formation passed through	Run on vein.
Number of feet run per shift	6 inches.
Length of ore shoot	400 feet.
Number of shoots being worked	1.
Greatest length of ground stoped	400 feet.
Pitch of ore shoot	North.
Kind of timber used in mine	Fir and pine.
Cost of timber	1 cent per foot.
Kind of powder used	Giant No. 1 and No. 2.
Length of levels	No. 1, 250 feet; No. 2, 400 feet; No. 3, 350 feet.
Quantity of powder used	200 pounds per annum.
Cost of mining per ton of ore	$2 per ton.
Distance from mine to timber	On the ground.
Distance from mine to lumber	15 miles from Merrimac.
Cost of lumber	$14 per thousand.
Length of road built by company	2 miles.
Cost of road	$500.
Length of ditch built by company	900 feet, and 800 feet of flume.
Cost of ditch and flume	$350 and $450.
Means of transporting ore	Tramway.
Cost of transporting ore to works	5 cents per ton.
Character of ore	Free-milling gold quartz.
Method of treating ore	Battery amalgamation.
Description of mill	Water-power mill, with 20 stamps.
Weight of stamps	950 pounds.
Drop of stamps	6 inches.
Drops per minute	95.
Height of discharge	8 inches.
Duty per stamp in twenty-four hours	$1\frac{1}{2}$ tons.
Kind of metal used for shoes and dies	Steel.
Cost of shoes and dies per pound	15 cents.
Wear of shoes and dies	2,000 tons to one set.
Quantity of water used in battery	One half inch.
Battery screens	Wire, Nos. 40 and 50.
Dimensions of screen inside of frame	42 inches by 5 inches.

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Vertical or inclined	Inclined.
Size of apron plates	4 feet by 3 feet, tapering.
Dimensions of plates in sluice	2 feet by 8 feet.
Size of plates inside of battery	4 inches by 42 inches.
Copper or silvered plates	Copper.
Inclination of plates	1 inch to foot.
Kind of feeders used	Tulloch.
Percentage of value saved in battery	66⅔ per cent.
Percentage of value saved on plates	33⅓ per cent.
Name of concentrator	Golden Gate.
Percentage of sulphurets	One half per cent.
Nature of sulphurets	Iron and galena.
Value of sulphurets in gold	$600 per ton.
Number of men employed in mine	2.
Number of men employed in mill	1.
Average wages paid per day in mine	$2 and board.
Average wages paid per day in mill	$3 50 and board.
Average wages paid per month on outside work	$40 and board.
Water or steam power	5-foot Knight wheel.
Cost of water	Owned by the company.

The water power is brought to the wheel through two nozzles; one nozzle is round and two inches in diameter, the other is oblong, four and one half inches by one and one half inches. They use sixty inches of water under ninety-nine feet of pressure. In the mill is a Blake rockbreaker and a Golden Gate shaking table, but the latter is not made use of.

Four miles beyond the Pappin Mine, to the southeast and out of the Granite Basin proper, is the

COQUETTE MINE.

It comprises three claims, known as the True Fissure, Baker Creek, and Bonanza. The mine is situated about thirty miles south of Quincy and forty-five miles from the railroad. The property is opened by three tunnels, respectively two hundred feet, two hundred and fifty feet, and three hundred and twenty-five feet long, and reaches a vertical depth of two hundred and twenty feet. The property was located in 1883. Up to date they have extracted about two thousand tons of quartz out of their vein, which courses north with a dip of 75 degrees to the east. Ingersoll machine drills are used in connection with a Clayton ten-inch compressor. With these they can run three feet of tunnel a day, using some days as high as twenty-five pounds of Giant powder Nos. 1 and 2. The vein averages two feet in width. The ore can be stoped for 50 cents a ton, the vein requiring no blasting. Is conveyed immediately into the mill over a tramway. Lumber at the mine is worth $12 per thousand, and timber about 2 cents per foot. There are two mills—a ten-stamp water mill and an eight-stamp steam mill, the latter to be used when the water gives out. The stamps weigh eight hundred pounds, and crush three tons per stamp, with a No. 6 screen. The water power consists of a six-foot Pelton wheel, worked with seventy inches of water under seventy feet of pressure. The company employs twenty men and pays miners $50 and board, millmen $40 and board, and amalgamators $5 per day.

About six miles north of Spanish Peak, at Rich Bar, on the east branch of Feather River, are a few small companies at work on placer claims. They have a water season of about seventy-five days, and are working the different bars along the river in that neighborhood with two or three men. Chinamen are also working in a few places.

Returning again to Greenville, and going from there north, the greater

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part of the country, soon after leaving the trap rock in the immediate surrounding of the valley, is basaltic lava, and continues into the Big Meadows and beyond to Lassen Butte. The west branch of the North Fork of Feather River has its source at the base of Lassen Peak, and flows through the Mountain Meadows and Big Meadows, and with other tributaries starts down the cañon of the North Fork near Bidwell's Bridge in the Big Meadows. At the Mountain Meadows metamorphic slates are to be seen, but beyond that the whole country is volcanic. The valley of the Big Meadows is about fifteen miles long and from two to three wide, and has an elevation of four thousand five hundred feet above the ocean. It is surrounded by volcanic tables three hundred or four hundred feet higher than the valley.

From Bidwell's Bridge, following the river down, the cañon rapidly narrows, and becomes exceedingly steep and rough.

About eight miles from the head of the cañon, having descended about five hundred feet, and being on the slates underlying the lava, which has been eroded along the course of the river, is the

SAVERCOOL MINE,

Also known as the Feather River Gold Mining Co., in Sec. 17, T. 26 N., R. 8 E. It is situated in the slates that form the northwest bank of the river. On the opposite side the lava capping, which is several hundred feet thick, is well exposed where it covers a part of the old river bed. The quartz in this vein makes in big swells, which show distinctly in their outcrop on the course of the fissure, and on which the seven tunnels that the company have driven are located. It has a ribbon structure, shows small intermediate strata of a chloritic schist, and accumulations of iron pyrites in which quite frequently free gold is interspersed. Iron sinter and stalactites form in places on the vein, and the water flowing out of the tunnels has a decided taste of iron.

Elevation above sea level	4,000 feet.
When located	1877.
Dimensions of claim	Four full claims abutting one another.
Mining district	Dutch Hill Mining District.
Name of nearest town	Prattville.
Direction and distance from town	South, 10 miles.
Direction and distance from nearest railroad	65 miles northeast.
Cost of freight from railroad to mine	1½ cents per pound.
Cost of freight from San Francisco to railroad station	½ cent per pound.
Course of vein	Northwest.
Direction of dip of vein	West.
Degrees of dip of vein	52½ degrees.
Average width of vein	8 feet.
Formation of walls	Black slate.
Tunnel or shaft	Tunnels.
Number of tunnels	7.
Length of tunnels	No. 1, 75 feet; No. 2, 380 feet; No. 4, 260 feet; No. 5, 75 feet; No. 7, 500 feet; No. 8, 128 feet; No. 9, 450 feet.
Cost of running tunnels	$6 50 per foot.
Vertical depth from surface reached in tunnel	About 1,500 feet.
Length of tunnel timbered	Very little.
Dimensions of tunnels	6 feet by 6 feet.
Formation passed through	Slate.
Number of feet run per shift	1 foot.
Length of ore shoot	150 feet.
Number of shoots being worked	3.
Greatest length of ground stoped	120 feet, in tunnel No. 4.
Pitch of ore shoot	West.
Kind of timber used in mine	Spruce.
Number of levels	9.

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there are three flowing wells, all situated two and one half miles east of Sacramento, in low-lying land, beneath the level of the surrounding country, in the edge of what is called Burns' Slough. Two of them are sixty feet deep, and one about two hundred feet. The former are five-inch wells, and when bored flowed four or five inches above the casing, where it was cut off close to the ground; the latter is an eight-inch, and flowed to about the same height.

The strata penetrated in boring were as follows:

Sandy loam	10 feet.
Hard porous sand, bored without casing	60 feet.
Water commenced to flow from this stratum, and gradually increased until the depth of sixty feet was reached.	
Whitish clay	10 feet.
Alternate strata of sand, gravel, and clay	120 feet.

It is stated that there was a slight increase in the amount of water from the lower strata of sand and gravel, but that the principal flow came from between the depths of thirty and eighty feet. When first bored, the deeper well yielded five thousand gallons per hour, the two shallower ones about one thousand gallons. The first seventy feet could have been bored without casing, but below that depth the wells had to be cased to keep out the fine sand. These wells appeared to be the only instances of flowing wells in the valley lands of Sacramento County. Possibly they are situated in an ancient bed of the American River, which, at that point, lies about eight feet below the level of the surrounding country.

The sandy strata which yields the flowing water probably crop out in the present bed of the American River at no very great distance from the wells, allowing a subterranean passage for the water. Similar occurrences are found near Woodland, to the south of Cache Creek, in Yolo County.

WATER SUPPLY AND SURFACE WELLS.

The city of Sacramento is supplied by water pumped from the river, and also by numerous private wells. The writer was informed at the city waterworks, that the average amount of water daily supplied by the company amounted to four million six hundred and ninety-four thousand three hundred gallons. In the summer time the average amount supplied was about forty million gallons per week, and during the winter months about half that amount. Potable water can be obtained in Sacramento and vicinity in strata of sand or gravel at a depth of from forty to eighty feet, but it is somewhat hard, and an abundant supply is obtained from a water-bearing sand at a depth of one hundred and forty to two hundred feet. The surface soil varies from red clayey or sandy loam to black adobe, the latter in many places becoming coated with efflorescent salts during the summer months. A little to the east of the city the gravel crops out at the surface of the ground, varying from a fine gravel to large cobblestones. These, no doubt, result from the shifting waters of the American River, which evidently at one time flowed farther to the south, its meanderings being traced by the old channels and river deposits which have been encountered by well borers to the south of the city of Sacramento.

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with iron was struck in a dark-colored sand and gravel. On the property of R. D. Stephens, about nine miles from Sacramento and a quarter of a mile from the southern bank of the American River, a well thirty-two inches in diameter was sunk to a depth of one hundred and thirty-four feet, and the following formations were penetrated:

Character of Strata.	Thickness of Strata, in feet.
Rich sandy loam	15
River wash, gravel, and cobblestones	10
Strata of hardpan, clay, and sand	100

At a depth of one hundred and twenty-five feet, a stratum of sand was penetrated for about nine feet, which yielded an immense quantity of water; it is said that a pump throwing a stream of water twenty inches in diameter fails to reduce the supply.

On the north side of the American River, the cobblestones and river drift, which are such a marked feature of the water-bearing strata on the south side of that stream, appear to be absent until the foothills are approached. Thus, three miles east from Arcade, a yellowish, sandy soil has been passed through for about thirty feet, toward the bottom of which there was a small amount of seepage water. This sand overlaid a stratum of hardpan about four feet in thickness, beneath which a white sand was penetrated for about twenty feet, and a good supply of water was obtained. The wells of that vicinity are usually between fifty and sixty feet in depth. A similar formation has been observed throughout the district bordering the American River upon the north, which lies between Arcade and the rolling land to the west of Folsom. In the vicinity of Folsom, the cobblestones and river drift are so heavy, the wells are usually dug to a depth of about thirty feet, and then bored to a total depth of sixty feet or eighty feet. The strata penetrated beneath the cobbles and drift are said to resemble those to the east of Arcade. Many of the wells are simply dug to the bottom of the river drift, but they are said to be unreliable in dry seasons. Across the river from Folsom, upon the higher ground, it is very difficult to obtain water, but some distance back from the river, it is said that sufficient water for house use can be obtained at a depth of eighty feet. South and east from the city of Sacramento, toward the center of the county, yellow clays and gravel are said to extend from the surface of the ground down to a depth of about thirty feet, beneath which are alternate strata of dark-colored clay and sand to a depth of one hundred or one hundred and twenty-five feet. The sand usually contains a good supply of water. Thus, upon the Finch Ranch, about two miles east from Florin, the following formations were seen:

Character of Strata.	Thickness of Strata, in feet.
Yellow clayey surface soil	22
Sand and gravel, with water	10
Dark-colored clay	30
Dark-colored sand, which was penetrated a few feet; this stratum afforded a good supply of water.	

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The well was cased to a depth of thirty-three feet. The ancient meanderings of the American River, especially near the foothills, can be traced by the gravels and cobblestones with which it has persistently strewn the parts of the valley over which it flowed. On the Spokane Ranch, eighteen miles east of Sacramento, and four miles south of the American River, a twelve-inch well was sunk to a depth of one hundred and three feet. It was first dug through a bed of cobblestones to a depth of about thirty feet, at twenty-five feet there was a little seepage water through the cobbles; boring was then commenced, and the following formation penetrated:

Character of Strata.	Thickness of Strata, in feet.
Blue clay	8
Small cobblestones	12
Yellow clay interstratified with thin layers of sand and fine gravel, which yielded plenty of good water	50
Bluish clay penetrated	3

This well yielded four thousand gallons of water per hour by pumping.

On the Dennis Dalton Ranch, near Howells, between the Cosumnes River and Deer Creek, a well was sunk in a gravelly loam mound, twenty-five to thirty feet above the Cosumnes River. The surrounding bottom land was a rich black loam of several feet in depth. The strata observed were as follows:

Character of Strata.	Thickness of Strata, in feet.
Gravelly loam	6
Hardpan	3
Fine dry loose sand	30
Reddish clay passing into light blue clay	40
Gravel with a small quantity of water	2
Hard sandy stratum (sandstone)	20
Grayish clay	25

Beneath the clay was a fine sand and quicksand, which yielded a good supply of water. This sand was penetrated a few feet, a small pump was used, and much quicksand was pumped out with the water; after a few days the water flowed clear. In a well bored on the Gill Ranch, about three miles south of Michigan Bar, the following formations were cut through:

Character of Strata.	Thickness of Strata, in feet.
Soil, reddish gravelly loam	7
Hardpan	10
Whitish clay	20
Cobblestones, with small quantity of "mineral" water	5
Dark-colored clay and seams of coal	10
Bluish clay, containing impressions of leaves and petrified wood; this stratum was penetrated about twenty feet; it appeared to be traversed by seams yielding a little water of inferior quality.	

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At the Linsay Ranch, between Howells and Sheldon, to the north of the Cosumnes River, the following formation was penetrated while boring a six-inch well:

Character of Strata.	Thickness of Strata, in feet.
Dark-colored loam	6
Gray sand, intercalated with cemented sand, with water	5
Clay and sand, mixed with fragments of waterworn rocks, and traversed by veins of water	45

The boring terminated in a whitish clay.

The various small veins of water were enough to supply a pump which pumped seven hundred gallons per hour. In the old channel of the Cosumnes River, which lies beneath the level of the surrounding country, water is obtained in beds of gravel at a depth of from fifteen to twenty feet.

About two miles northwest from Sheldon the following strata are found:

Character of Strata.	Thickness of Strata, in feet.
Sandy soil	8 to 9
In some places the soil is clayey loam, and shallower.	
Sandy hardpan	15 to 20
Cement and cobblestones	2 to 5
Reddish clay	8 to 12
Clean coarse gravel made up of pebbles and small cobblestones; this stratum was usually penetrated from three to five feet, and yielded a good supply of water, which rose eight to ten feet in the pipe.	

A fourteen-inch well was bored through this formation on the Lewis Ranch, which stood without casing. Numerous small fish are said to have been pumped up in the water from a well on the Lewis Ranch. Immediately around Sheldon many wells are dug entirely in cobblestones to the depth of about fifty feet; good water seeps through the cobbles, but the amount is limited. Nearer to the Cosumnes it is said to be good boring; there the strata are as follows:

Character of Strata.	Thickness of Strata, in feet.
Dark, sandy loam	10 to 12
First water at a depth of ten feet.	
Yellow clay	40 to 50
Dark-colored sand and gravel, containing a good supply of water, which is usually penetrated a few feet.	

Upon the banks of the Cosumnes River, a blue clay is said to take the place of the yellow.

Crossing the river to a point about five miles east of Galt, the following formation is found:

Character of Strata.	Thickness of Strata, in feet.
Red clayey or gravelly soil	3
Hardpan	½ to 3
Bluish clay	20 to 35

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The first water is generally found seeping through holes in this clay, and thin strata of sand and gravel are frequently encountered. Beneath the clay is a gravel which is usually penetrated a few feet, yielding an inexhaustible supply of water by pumping. In the neighborhood of Clay good water is obtained at a depth of from eighty to ninety feet. The surface consists of a yellowish clayey loam, which, associated with numerous cobblestones, extends to a depth of about sixty feet; water seeps through this formation during the winter months. The clay loam passes into a hard, tough, yellow clay, which is from eighteen feet to twenty feet in thickness. The hard clay overlies a gravel, from which a good supply of potable water was obtained. The water-bearing strata lie deeper as the foothills are approached, and cobblestones and small bowlders frequently impede the boring.

NATURAL GAS.

On the Haggin Ranch, nine miles northeast from Sacramento, in a well bored two thousand two hundred and fifty feet, inflammable gas comes to the surface. During the winter of 1889 and 1890, the Sacramento Natural Gas and Water Company was organized, with a capital of $20,000, to sink a well for artesian water and gas in the southwestern part of the city. The contract has been let for two thousand five hundred feet, commencing with a twelve-inch casing. The following formations have been penetrated up to date:

Character of Strata.	Thickness of Strata, in feet.	Depth of Well, in feet.
Soil, clayey and sandy	31	31
Bluish sand	16	47
Coarse gravel, with cobblestones	54	101
Blue clay	1	102
Cemented sand	1.5	103.5
Whitish clay	1.5	105
Sand passing into cemented sand	42	147
Blue clay	57	204
Bluish quicksand	2	206
Blackish cemented sand	6	212
Bluish sand	15	227
Bluish cemented sand	12	239
Bluish sand with streaks of quicksand	26	265
Tough blue clay	3	268
Fine blue quicksand	1	269
Blue clay	7	276
Dark-colored indurated sandy clay	5	281
Sand; the water raised several feet, and some gas showed	6	287
Sandy blue clay	12	299
Greenish blue clay	2	301
Sandy indurated clay	31	332
Quicksand.		

SALINE WELLS—THE HAGGIN WELLS.

About twenty years ago, two wells were bored on the Haggin Ranch, on the Norris tract, about nine miles to the northeast of the city of Sacramento. They were bored to a depth of two thousand two hundred and fifty feet and one thousand six hundred feet, with the hope of finding flowing water. None was obtained, but the wells yielded salt water by pumping, and a small quantity of inflammable gas arose in the deepest

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well. Wells bored within a hundred feet of these, to a depth of from sixty to one hundred feet, have yielded a good supply of fresh water. These later borings penetrated strata of sand and clay. A record of the formation penetrated by the Haggin wells and samples of the strata were preserved by the Agassiz Institute. Five bottles of samples, with date and depth attached, representing strata from seven hundred and twenty-five feet to eight hundred and seventy-one feet, are now in the possession of the California Museum Association, of Sacramento, and are as follows:

Contents of Bottle.	Depth from which Obtained.	Date.
Fragments of crystalline rocks	725 feet.	November 28, 1871
Dark-colored sand, with clear particles of quartz	780 feet.	October, 1872
Cemented sand of lighter color	820 feet.	November, 1872
Granitic pebbles	850 feet.	November, 1872
Small clastic fragments of crystalline rocks	871 feet.	November 28, 1872

BRICKS.

The Sacramento Transportation Company, in connection with their steamboat business upon the Sacramento River, manufacture brick for the San Francisco market to the extent of twenty millions of bricks per annum. They have two brick plants—one of the capacity of seventeen millions per year, which is situated on the Sacramento River, near Riverside, about five miles south of the city; and the other, of a capacity of four millions per year, also on the river, in the vicinity of Freeport, nine miles south of town.

These brickyards have been established eleven or twelve years; about two years ago new machinery and boilers were put up, greatly increasing the capacity of the works. At Riverside, the works consist of five Quaker brick machines, with a pug mill attached to each, a dredger for excavating, and a railroad for transporting the material from which the brick are made. Two large continuous kilns are used, of the latest pattern, which turn out fifty thousand bricks per day. The plant and grounds occupy about three hundred acres. The raw material is taken from low-lying lands about a quarter of a mile from the Sacramento River, and consists of a dark, loamy soil, beneath which is a micaceous, grayish clay, and underneath the clay a stratum made up of sharp river sand, the total depth of the strata used being about twelve feet. The material is dredged with a steam shovel, which not only partially mixes the material, but allows excavations to be continued unimpeded by water during the wet periods of the year. The brick material is piled on the bank of the excavation to "season," and hauled by steam cars to the works upon the banks of the river. The material is then tempered with water, and thoroughly mixed by the pug mills, from which it passes automatically to the brick machines, where it is molded into bricks; the molds are sanded by machinery, and the surplus clay taken from the molds is returned by endless belts to the hoppers of the pug mills.

The brick machines are connected with a line of shafting which is run by a one hundred and thirty horse-power engine. The capacity of each machine is thirty thousand bricks daily. The green bricks are placed on pallets, six bricks to the pallet, and six pallets at a time are

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wheeled to the drying yard, where they are stacked in tiers ten pallets high. The bricks remain on the drying ground six days, and are then ready for the kiln. A part of the production is stored, to be burnt during the winter. The continuous kiln is of an oval shape, one hundred and sixty feet long, sixty feet wide, and twelve feet high. The center smoke chamber is surrounded by a hollow space fifteen feet wide, which contains the bricks. Walls and roof of the kiln are lined with fire-brick. There are sixteen doorways around the kiln, by which bricks are taken in and out. As soon as a portion of the kiln is filled, ready for burning, the doorway belonging to that section is bricked up. A system of flues extend through the outer walls and open close to the floor of the kiln. These flues, assisted by openings near the floor in the side of the smoke chamber, give a downward draft to the kiln, the smoke chamber and flues being connected with a smokestack about one hundred and thirty feet in height. The roof of the kiln is perforated by a series of firing holes about three and one half feet apart, each of which is fitted with an iron cap. These firing holes extend into the kiln and connect with interstices purposely left between the green bricks when the kiln is filled. It is in these that the fire is started, and maintained during the process of burning by being gradually fed with small coal. By this method the operation is a continuous one, some parts of the kiln being discharged and refilled, while others are in various stages of burning or cooling. During the discharging and refilling, that particular section is kept cool by a fan blast.

The bricks are delivered on barges in the river, capable of carrying two hundred thousand each. These works employ about one hundred and sixty men from April to November, and about forty during the remainder of the year. The laborers, who are mostly Chinese, are employed on piece work where practicable.

The plant at the Freeport yard consists of one Martin brick machine with pug mill attached, run by horse power, and three Eudala patent kilns for burning common and fancy bricks. The raw material is obtained on the banks of the river, from whence it extends eastward for about one mile, and then changes into black adobe clay which is unfit for brick-making. The brick material is a dark, loamy, micaceous clay which becomes lighter in color on exposure to the air; it is interstratified with a more sandy clay. The material is extracted by manual labor, which assists in mixing the sandy and clayey portions; this work is carried on during the summer and fall; the material is then left to "season" till the following year. The seasoning process is said to make the material more compact in texture, and brings it to a better consistency when tempered. In the process of manufacture, the material is first placed in a pit, and sufficient water added to temper the clay, and in this condition allowed to stand over night; it then goes to the pug mill, which is worked by horse power; from there it passes automatically into sanded molds, in which it is pressed, being discharged as "green bricks," which are spread in the yard to dry. After a few days drying they are ready for burning. The sand for sanding the molds is obtained in the early autumn from a bar in the river.

There are at the Freeport works, two oblong and one circular Eudala down-draft kilns; the oblong ones are twenty-four feet wide, sixty-four feet long, and sixteen feet high. They are fired by five fireplaces on each side; either wood or coal can be used in these kilns; the flames from the

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home market, shipping the bricks as return freight at a low figure. At present they are fully occupied supplying the home market; they burn from two to three million per annum. At both of the above mentioned yards, the material for the year's supply is taken out during the previous autumn and allowed to "season," thus avoiding hinderances from water accumulations during the winter.

THE CAPITAL SEWER PIPE WORKS.

These works were established about twelve years ago in the eastern part of Sacramento City for the manufacture of sewer pipe, stoneware, firebrick, and terra cotta ware. The plant consists of a steam sewer-pipe press, machinery for grinding and tempering the clay, together with two down-draft kilns, and a steam power for running the works.

About fourteen hands are employed; the raw material they work on is supplied from the coal measures of Carbondale, in Amador County, also from Live Oak, in Sacramento County; the latter is the better clay, but superior facilities for transportation render the former more available. The clay from Carbondale and Live Oak is white, and for making terra cotta ware is mixed with yellow clay from the banks of the American River. The coal ashes from the boiler furnace are also ground up with the clay used for manufacturing sewer pipe. The clay used for the stoneware is a fine, white, smooth clay, without grit. A clay containing sharp quartz sand is used for the firebricks; it is also mixed with the material from which the terra cotta ware is manufactured. The sand gives the material a "looser body" and prevents cracking in burning. White clay, both with or without sand, is found at Carbondale. The dry clays are mixed in the required portions and ground to a powder by revolving wheels in a rotary pan, then tempered to the required consistency, the larger articles requiring the stiffer clay. When sufficiently plastic, the clay is conveyed by an endless belt to an upper floor, where the material for sewer pipes passes into a Vaughn sewer-pipe steam press, issuing below as a pipe of the required size. This press has a capacity of two thousand two hundred pipes per day, the sizes made ranging from three to twenty-four inches; the green or unburnt pipes are then placed on a drying floor, and when dry are glazed.

The glazing is effected either in the furnace with salt, or by Albany glazing. The salt glazing is produced by adding salt to the fuel in the furnace. The Albany glazing is a clayey substance which is mixed with water and applied as a wash. The fire clay destined for the manufacture of other articles is molded by hand to the required shape; the molds being made of plaster of Paris, the clay remains in the mold till solid enough to bear removal. Stoneware is formed on the potter's wheel. The unburnt utensils are placed on the drying floor, then glazed when dry, and placed in the kilns. There are two circular kilns, one seven feet, the other eight feet high, and respectively twenty-two feet and twenty-six feet in diameter outside, and eighteen feet and twenty feet inside. They have seven and eight fireplaces, respectively, and are lined with firebrick. The flames pass up "bags" to the crown of the kiln, where they reverberate and pass down to flues in the floor of the furnace, which connects with the smokestack on the outside. The time of firing varies from thirty to sixty hours, according to the fuel used

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the stream. They propose to mine this as soon as the river is drained by the canal.

Below the State Prison, the whole of the water diverted on the east side of the river will flow through the company's canal toward Folsom, a distance of about one and a third miles, with a grade of about two and a half feet to the mile. At Folsom a portion of the water will be returned to the river, with a drop of about eighty feet, which it is estimated will develop a force of about seven thousand horse-power. The company contemplate establishing various factories at this point.

The remainder of the water in the canal will be conducted farther to the south, and distributed by a system of irrigation throughout lands lying between the American and Cosumnes Rivers. Water will also be sold to miners operating in the foothills along the track of the canal. On the west side of the river the company owns another water right, and they are constructing a canal which will extend in a westerly direction throughout the territory lying between the American and Feather Rivers. The water will be used for irrigation, and its falls for power.

The canal on the west side of the American, where it leaves the dam, will be forty feet wide at the top, thirty feet wide at the bottom, and six feet deep.

THE FOLSOM GRANITE COMPANY.

The Folsom Granite Company has been in operation as a separate organization with concessions from the Folsom Water Power Company. They will operate extensive granite quarries, which are situated above the dam on the west side of the river. At this point, quarrying and dressing stone have been carried on for several years, and large quantities have been shipped to San Francisco and various other points. The stone will be brought down on scows from the quarry to the landing stage of the Folsom Water Power Railroad, which connects with the Sacramento Valley Railroad at Folsom. The water power will be used for dressing and polishing the rock.

THE AMERICAN RIVER LAND AND LUMBER COMPANY.

The American River Land and Lumber Company has been incorporated as a separate organization, with concessions from the Folsom Water Power Company.

The object of this company is to develop the lumbering interests along the upper waters of the American River. The dam already described backs the water up both forks of the river for a distance of some miles, and in the still water basin so formed, the Land and Lumber Company have erected heavy masonry piers to support a boom. The counties of Sacramento and Placer have each conceded "boom privileges" to this company, with the use of the waters of the American River, for the purpose of developing the lumber interests throughout the territory drained by the river.

It is stated that an immense amount of valuable timber, which has hitherto been regarded as inaccessible, will be brought to market by the enterprise of this company.

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SAN BENITO COUNTY.

By Myron Angel, Assistant in the Field.

This county lies between the Gabilan and the Mount Diablo Ranges of mountains. These mountains come together in T. 20 S., R. 12 E., M. D. M., and standing northwesterly embrace the valley and county of San Benito. Between these ranges of mountains is the San Benito River, which forms a part of its northern boundary, and along it and its tributaries are several handsome and fertile valleys.

The principal resources of the county are in its agriculture, for which the soil of the valley, as well as of the mountain slopes, is very favorable. The mountains bordering the main valley are grass-covered to their summit, and generally arable.

The elevation of Hollister is two hundred and ninety-two feet above the sea. The average temperature, as given by the United States Signal Service, shows 59.5 degrees for the year, the highest range being 109 and the lowest 21 degrees. The average rainfall is twelve inches in the valley, but is much greater in the mountains.

MINERALS.

While this county is regarded as essentially agricultural, yet to an observer it appears to possess mineral resources of equal importance to others in the State. The Mount Diablo Range has proved of incalculable wealth in its coal, quicksilver, copper, chrome, petroleum, ochre, and antimony; and in the Gabilan Range, lime, gypsum, and iron are present. Gold and silver have been reported, gold being obtained from placers.

The New Idria Quicksilver Mine in this county has a good record; a full description of which appears in report of 1888.

M'LEOD DISTRICT.

This district embraces the summit of the Mount Diablo Range extending into Merced and Santa Clara Counties. On the northern and eastern slopes of the mountains are veins of quicksilver, and on the western slope there are veins of antimony. These were discovered in 1861. Staytonville, in Merced County, is situated in Secs. 4 and 5, T. 12 S., R. 7 E., M. D. M. From and including these sections, six or seven miles north are many veins of quicksilver, a number of which have been exploited. The principal ones are the Stayton, North Star, Woody, Gypsy, Cincinnati, Dalzell, Black Giant, Mountain View, and farther north the Mariposa, China, and Comstock. These have been worked from time to time, but never with great success. The veins are large and are reported to furnish ore containing 2½ per cent of quicksilver. In 1889 a renewed effort was made to reopen and work the Cincinnati, Gypsy, and other mines belonging to the Gypsy Mining Company. They have commenced the erection of a ten-ton furnace, for which there is said to be sufficient

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SAN BERNARDINO COUNTY—ITS MOUNTAIN PLAINS AND VALLEYS.

By Dr. Henry De Groot, Assistant in the Field.

Topographically viewed, this county may be considered an elevated plateau or plain, occupied or traversed by numerous mountains, some of which stand in irregular groups or isolated masses, while others stretch out into long ranges, flanked by foothills, and having a generally north and south trend.

This plain, from an elevation of less than a thousand feet on the south, rises in the central and northern parts of the county to a height of four thousand feet or more.

Scattered about between these higher mountains occur many volcanic cones, buttes, and clusters of broken hills, not more than two thirds of the entire area of the county, consisting of level, or nearly level ground. Foremost among these isolated masses is the rugged elevation known as

MOUNT SAN BERNARDINO,

Which, standing in the southwestern angle of the county, lifts itself to a height of eleven thousand six hundred feet above the level of the sea. It is precipitous on all sides, its declivities being rocky, and nearly everywhere difficult of ascent. For more than half the year the higher portions of this mountain are covered with snow, which melting, keeps the larger streams, having their source in it, well replenished until late in the summer, the most of them flowing the year round.

It is to this abundant supply of water, now all appropriated for irrigating purposes, that the country adjacent on the south and west is indebted for its unbounded fertility. From the forests on this mountain, the local demands for fuel and lumber are in good part met, the body of timber standing here being the largest and best found in the southern part of the State.

Measured through its base in any direction, Mount San Bernardino extends fully thirty miles.

One of the peaks of this mountain, though not the highest, constitutes the initial point of the public land surveys for Southern California, the base line and meridian passing through it. This peak is more than a thousand feet lower than the extreme summit of the mountain known as "Grayback," the crest of which extends three or four miles in an easterly and westerly direction.

A long straggling chain of mountains, stretching southeast from the central San Bernardino group, having by some topographers been considered a continuation of this mountain, has so been designated on their maps, though to different portions of this chain local names have been given.

Southeast of San Bernardino some twenty miles, and separated from it by San Gorgonio Pass, stands

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Sections of it are well timbered with yellow pine and other coniferous trees, from which enough lumber is cut to supply the needs of the country adjacent. There is also a considerable extent of farming lands along the base of this mountain on the east, whereon a good deal of hay, fruit, and grain is raised, and much stock pastured.

Lying off in the same quarter are Kingston, Old Woman, and Clark Mountains, all rugged and lofty, reaching from six to eight thousand feet in height.

Sixty miles north from the town of Daggett, near the road leading to the Searles Borax Marsh, is another lofty and isolated eminence known as Pilot Peak, and which, standing so alone and being exceedingly steep, serves as a guide to travelers on the desert. The Ivanwatch Mountains, a craggy and broken chain, overlooks Death Valley from the southwest. It is seventy miles northeast of Daggett, sixty miles in nearly the same direction from the crest of the Calico Range, whence it can be seen, its summit being over seven thousand feet high. There are several other ranges of mountains on this great Mojave waste, some of them nearly as high and otherwise as notable as those above mentioned.

There are but few valleys in this county of sufficient importance to deserve special notice.

What are here sometimes termed valleys are simply widely extended plains; the so called valley of San Bernardino furnishing a case in point.

The mountain valleys are for the most part nothing but narrow, rocky gorges, few of them containing even so much as an acre of level land or tillable soil.

MINES AND MINING.

The business of mining for the precious metals in this county has, since the issuing of our last report, shown some improvement, both as regards vein and

PLACER OPERATIONS,

Bear and Holcomb Valleys and the several creeks that flow westward from the San Bernardino Range constituting the principal sites of the latter. Placer mining has been carried on in these localities since 1860. For a long time, and until recently, it had been on the decline, but the abundant rains of last winter affording a good supply of water has had the effect of infusing new life into the business. From January till August this year, about one hundred men made an average of about $4 per day each gravel washing in this part of the county. The majority of this placer gold is supposed to have come from the disintegration of the quartz lodes that traverse the westerly slope of Mount San Bernardino, and some of which, carrying small, rich stringers of quartz, have paid well when worked with hand mortars or arrastras. Much of the gold found in these ravines is coarse, the gravel washed yielding often from $10 to $15 to the barrow load, and chispas worth as much as $4 having been picked up.

While some hydraulic mining has been carried on in this county, chiefly in Bear and Holcomb Valleys, the most of the placer mining is done with the sluice and rocker, the latter being employed mainly in

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the small gulches and other localities where the gravel is apt to be rich and water in scant supply.

Besides these placers, along the slopes and in the higher lying valleys of the San Bernardino Range, similar deposits are found in a number of other localities in this county, some of these having been worked, so far as water could be obtained for doing so. Even on the higher ridges, and sometimes on or near the summits of the mountains, gold-bearing gravels appear; so, also, are they met with, both on the surface, and at considerable depths below it, out on the desert. What is known as the Golden Eagle Claim, comprising an area of thirteen acres, lies on the very crest of the divide, between two of the principal peaks in the San Bernardino Range, and at an elevation of six thousand feet above sea level. The surface dirt here is rich, and has been extensively worked by the owners.

Near the town of Victor, situated on the Mojave Desert, sixty miles north of San Bernardino, a placer claim, lately opened, and now being successfully worked, carries paying material from the surface to a depth of fifty feet. The first twenty-six feet passed through shows free gold in paying quantities diffused all through it. Next, underlying this, a fourteen-foot stratum of volcanic ashes is found to carry more or less wire silver. Below this, the auriferous gravel coming in again has held as far as sunk upon. Still farther on, in the vicinity of the southerly rim of Death Valley, as well as at numerous other localities lying off in that direction, placers are known to exist; but very few of them can be worked to any advantage, owing to an almost entire absence of surface water. As artesian borings have been prosecuted here with success, the day may come when some, if not the most, of these deposits can be worked with profit.

THE MILL CREEK, BOX SPRING MOUNTAIN, AND THE PANACATE DISTRICTS.

Besides these placer deposits so scattered over this southwestern angle of San Bernardino County, and which comprises less than one tenth of its entire area, there occur here a great many gold and silver-bearing veins, the most of them marked by good mineral indications, some having been sufficiently exploited to establish for them large and unmistakable values.

These deposits are located, for the most part, in the several districts above named, a greater portion of them being in the Panacate country, situated about twenty miles from Colton in a southerly direction, a portion of this region reaching down into San Diego County. Vein mining in that locality is not wholly a modern industry, there being proofs on the ground that it was pursued there before the American occupation of California. It was, in fact, the finding of a shaft put down, and from which ore had evidently been extracted many years ago, that led to the discovery of the numerous ledges since taken up in this district. This discovery was not altogether a surprise to the older settlers, who had heard of vein mines being worked here in former days; also, placer mining was being carried on in the vicinity of this old shaft by Mexicans and Indians. Mexicans had long been in the habit of picking out small bunches of rich quartz from this neighborhood, prior to the rediscovery of the old shaft, or possibly they may have obtained it from the shaft itself, the Mexican prospector and miner usually only following rich

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seems to be distributed throughout the entire mass of vein matter. Where this occurs, though of low grade, it is thought much of the ore can, by careful assorting, be profitably mined and reduced, the facility with which it can be extracted and transported to the mill contributing largely toward that end. While it would be possible, by extracting only the richer streaks, to obtain ore that will yield $50 per ton, the great mass to be handled will only yield from $4 to $16 per ton. It will be possible to work these claims for a long time as quarries, conducting the ores to the mill by gravitation through chutes of planking down two hundred feet into the ore bins. At present the ore is simply thrown over the cliff and reaches its destination. With a large mill the total expense can be brought within $4 per ton, or perhaps less. Fuel is, and always will be, the main item of expense, costing at present delivered at the company's mill $4 per cord.

As the mountains to the west are covered with a heavy growth of piñon, which makes the best of fuel, the supply within easy reach will not soon be exhausted. It might be found expedient to build a small railroad to the Mojave River and place the mill where water power could be had. Or the mill might be placed at the mouth of the cañon, and water for driving it be brought in from Holcomb Valley, a project now being considered.

Hoisting and pumping are two items that will not need to be taken in consideration here for some time to come. Water for the present mill is brought in from a group of springs owned by the company, located about seven miles southwest; it being conveyed through iron pipes. They afford two hundred and fifty thousand gallons per day, and might be made to yield more. Some little water is also obtained from springs located along Lookout Cañon. The pipe-line cost the company about $30,000. The improvements on the property consist of a ten-stamp steam mill, boarding and lodging houses, shops, barns, stables, etc. The company has built a good wagon road up the cañon, and trails to the springs and the timber. The mill started up the first of August, and has been running part of the time since, but not with satisfactory results, owing to the difficulty of saving the gold with the appliances in use. The gold bullion turned out is worth $17 per ounce. In addition to their mining claims, the company has purchased the Cushenberry Ranch, six miles west of their mines, where they raise a large amount of needed supplies. The crushing capacity of the mill is to be soon greatly enlarged, unless a new and large mill be erected on another site. The property is to be patented, preliminary surveys having been made for that purpose.

THE RUBY DISTRICT,

Wedge-shaped, about twelve miles long, adjoins the Black Hawk and Morongo Districts. It has only a few claims that are being occasionally worked, although there are a number of good-looking lodes in the district.

THE MORONGO DISTRICT

Is bounded on the northwest by the Black Hawk, and comprises parts of T. 2 N. and R. 5 and 6 E. It lies forty-six miles north of Seven Palms

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Station, on the Southern Pacific Railroad, and at an altitude of five thousand feet above the sea.

The most largely developed lode in this district is the Morongo King, which, together with the Overly Scott, and the Glasgow, constitutes what is termed the Morongo King group of mines. All these claims are situated on one lode, having a general northeast and southwest strike, dipping to the west at an angle of about 65 degrees. The vein crops out for several hundred feet. On the Morongo King they have a shaft sunk to a depth of one hundred and eighty feet. At one hundred feet two drifts have been run on the ledge for a distance of thirty feet. All these workings show bunches of free-milling gold ores, of which between eighty and ninety tons are on the dump. The ore carries a large percentage of sulphurets. Eighty feet northeast of this shaft another has been sunk thirty feet on the ledge, which here shows a thickness of four and one half feet. Near the north end of the Overly Scott Claim a fourteen-foot shaft shows a seven-foot ledge of similar ore.

The Nichols Mine has been opened by four shafts sunk on the vein, which is twelve feet wide, and contains a high-grade ore. The shafts are one hundred feet, seventy feet, thirty-eight feet, and twenty feet deep, respectively, and work is kept up with the prospect of developing a very valuable property.

Not far from the above mine is the Rattlesnake Claim, on which a good deal of work has been done, developing a fine body of ore that carries from forty to sixty ounces of silver to the ton, and a small percentage of gold.

Five miles west of the Morongo King Mines wood and water can be had in fair supply. Antelope Springs, one and a half miles to the east, also afford enough water for the use of a mill. On the Capital, Scandalosa, and Monitor Claims, shafts have been excavated, varying from ten feet to fifty feet in depth, each of which show fair prospects in gold. There are several other lodes in this district which seem to carry either gold or silver, and sometimes both in paying quantities.

TWENTY-NINE PALMS DISTRICT,

Which adjoins the Morongo District on the east, includes the greater portion of T. 1, 2, and 3 N., R. 8, 9, and 10 E., being near the vague and not well-defined boundary between the Mojave and the Colorado Deserts. There are many metalliferous lodes in this district, the most of them gold-bearing. They are rather narrow, ranging from one to three feet in thickness. While a good many of these lodes have been somewhat prospected, but little deep work has been done. Some of the ore worked by arrastras yielded as high as $100 per ton, and nearly all of that worked by the two small mills in the district has been of high grade.

This district being well out in the desert, neither wood nor water is in large supply. There are, however, several large springs in the vicinity. From one of these issues a stream sufficiently strong to flow for three miles before it disappears in the sand. The most of this flow could be arrested and stored, there being near the spring an eligible site for a reservoir.

Although mineral-bearing lodes are known to exist east of this locality, no mining districts have as yet been organized in that direction.

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THE BURROUGH'S DISTRICT

Commences at the mouth of Burrough's Cañon, where the Mojave River debouches from the mountain, follows up that stream to the southwesterly line of the Holcomb Valley District; thence northerly to the desert; thence skirting the base of the mountains to the place of beginning.

THE GOLD AND SILVER MINING DISTRICT,

Organized from what was formerly a part of Burrough's District, is bounded on the south and west by Deer Creek, on the north by the Mojave Desert, and on the east by Holcomb Valley. This and the Burrough's District cover most of the territory included in T. 2 and 3 N., R. 2 and 3 W. There are numerous gold and silver-bearing lodes in these two districts, but there has not been enough work done in either to require particular mention.

THE SILVER MOUNTAIN DISTRICT,

Equally well known as the Oro Grande, the principal town in the district. It commences at Stoddart's Crossing on the Mojave River; thence southeasterly to Rabbit Springs; thence southwesterly to the Panamint Crossing on the Mojave River; thence due west to the county line between Los Angeles and San Bernardino; thence to the southeast corner of Kern County; thence to the place of beginning, this district covering about twenty townships lying in the southwestern angle of San Bernardino County.

On the banks of the Mojave River, which extends through the eastern part of the district, is situated the town of Oro Grande, containing about one hundred and fifty inhabitants. It stands near the center of the district in T. 6 N., R. 4 W. Being on the Southern California Railroad, this town is a supply and shipping point to a large extent of farming and mining territory, there being a considerable amount of good agricultural land along this section of the river. The town of Victor, six miles to the south, containing about one hundred inhabitants, is also located on the river with the railroad running through it.

It was in this district that the earliest discoveries were made in the western part of the Mojave Desert, this having occurred about ten years ago. Following this event, a good deal of work was done during the next two or three years, a ten-stamp mill having been erected in 1881. This mill, however, owing to the impossibility of reducing the ore by the method adopted, proved a failure, a result that gave the district a temporary set-back. The mill has lately been supplemented by a smelter better adapted for treating a majority of the ore, much of which is lead carrying silver. Some of the smaller ledges contain only gold.

The mines are in the foothills and low mountain ranges, from ten to fifteen miles in nearly all directions, about the town.

In 1887 another ten-stamp mill was erected at the town of Victor for working the ore from the Sidewinder Mine, situated ten miles to the east in Highland Mountain at an elevation of three thousand eight hundred feet. The vein, which crops out for over half a mile, stands between a hanging wall of metamorphic slate and syenitic foot wall. An incline shaft has been sunk to a depth of one hundred and twelve

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the latter is a vein sixty feet wide, as shown by the crosscutting. A number of shafts have been sunk and a long tunnel driven, it being practicable to obtain here by tunneling backs more than eight hundred feet deep. The great body of the ore developed in this district is, at the present time, of no value, as it carries an average of only $8 per ton in gold, not enough to pay the expense of working on the ground or of shipment. With much improved facilities for either, it would become proportionately valuable, as it exists in great quantities. A few small springs supply all the water to be had in the district.

In the southwesterly part of this district, at a point twelve miles north from Rabbit Springs, a rich deposit of chloride and hornsilver, with some gold, was struck in the fall of 1889. Several small lots of this ore sent to the Selby Smelting Works yielded large returns. As but little work has been done on this vein, which is narrow and occurs in lime, its actual or even prospective value has not been determined. Much prospecting induced by this strike has not, as yet, resulted in any valuable discoveries. This claim is known as the Cox.

DRY LAKE DISTRICT,

Lying southeasterly from Ord District, and north of Eagle Mountain, is situated in T. 6 N., R. 4 E., a large portion of it occupying what was once the bed of a lake, now, for the greater portion of the year, dry. Dry Lake is fifty miles east of Victor, on the California Southern Railroad, from which place freight is hauled to the district.

The ledges are numerous, but not generally large, and carry a low-grade gold ore. Several arrastras were at one time run on this ore, which, by close selecting, yielded over $100 to the ton. A ten-stamp mill was put up here in 1887, but has not been run steadily since, nor has much been done in this district of late. There is no timber here, though water in moderate quantities can be obtained by digging down in the old lake bed from twenty to thirty feet anywhere along the base of Eagle Mountain. The mineral belt has a length of nine miles by a breadth of about five miles. There were no permanent residents in this district at the time of visit in May, 1890.

THE LAVA BED DISTRICT,

Which adjoins the Dry Lake District on the north, comprises T. 7 N., R. 4 E., and T. 7 N., R. 5 E., the principal camp being about eight miles south of the Atlantic and Pacific Railroad. In this district, which was established ten years ago, there are a great many large ledges carrying gold, silver, and lead, the ores of which are of good grade. They strike northwest and southeast, and can be traced for two miles, and range from ten to twenty feet in thickness. The mines on which the largest amount of work has been done are the Morning Star, De Soto, Meteor, Mammoth Chief, Sampson, and Black Hawk, on all of which a good deal of development work has been performed, by means of tunnels, shafts, open cuts, etc., some of these tunnels being over one hundred feet long.

The prevailing formation is porphyry traversed by trap dikes, nothing but eruptive rocks being seen. The vein matter is of a calcareous nature, the more valuable ore consisting of hornsilver and black sulphide of silver, some of it being rich. The amount of bullion produced is small,

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no mill having been erected in the district. While exploratory work was quite active six or seven years ago, very little has been done here of late.

THE CALICO DISTRICT

Comprises an area ten miles square, having its southwest angle at a point near Little Red Buttes, two and a half miles west of the Waterloo Mills on the Mojave River, the boundary lines running with cardinal points of the compass. The district includes T. 10 N., R. 1 E., and the S. ½ of T. 11 N., R. 1 E., and W. ½ of T. 10 N., R. 2 E.

Within the above limits is included the most of Calico Mountain, situated in the northerly part of the district six miles north from the town of Daggett, this mountain being the site of the Calico Mines, the most extensively worked and largely productive group in San Bernardino County, they being also the principal silver mines in the State of California.

Daggett, the principal town in the district, is located on the line of the Atlantic and Pacific Railroad, the Mojave River flowing by it. It lies north-northeast from the city of San Bernardino, with which it is connected by the California Southern Railroad, eighty-five miles, and at an altitude two thousand feet above the sea. It contains about three hundred inhabitants, and is the receiving and distributing point for a large extent of country lying to the north, east, and south. The town is an active business and milling center, notwithstanding it has suffered much from disastrous conflagrations, the last of which occurred in the summer of 1890.

Calico is a small camp situated seven miles north of Daggett, in the vicinity of many claims and some of the principal mines in the district.

Both the mines and the mills actively operated in this district having, in recent reports issued by the Mining Bureau, been described with much fullness, these properties require hardly more than brief mention at this time. The sixty-stamp mill, described in former report as being constructed by the Oro Grande Company to replace the one shortly before destroyed by fire, has been completed and run with results satisfactory to the company. The number of men employed by this company in mine and mills has, since last report, been increased from thirty to two hundred, the output of ore amounting now to two hundred tons every twenty-four hours, this quantity being reduced by the two mills, one of sixty and the other of fifteen stamps. The railroad for transporting the ore from their principal mine to the mills, a distance of five and one half miles, is also completed. The exploratory work on the Waterloo has been pushed in every direction.

The submerged dam being put in by the Silver Valley Land and Water Company in the Mojave River, at a point three miles above Daggett, designed to employ the subterranean water of the stream for motor and irrigation purposes, has been completed.

Several mines in Calico that had for a time been idle, have lately resumed operations, with every prospect that they will be worked continuously. Work was again started in the fall of 1889 on the King, since which they have been running both mine and mill steadily. This mine has more than a local reputation for the extent and richness of its ore bodies.

There is now being run about one hundred and fifty stamps, or their

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yields $20 per ton in free gold, the bullion ranging from nine hundred and thirty-eight to nine hundred and ninety fine.

THE TROJAN DISTRICT,

Or, as it is better known, the Providence District, is about one hundred miles easterly from the town of Daggett. This district has become conspicuous through its being the site of the Bonanza King Mine, which produced from 1883 to 1887 at the rate of $60,000 per month, the expense of mining and milling being small. The ore averaged $100 per ton, and was worked up to 80 per cent of its assay value. The bullion averaged nine hundred and thirty fine. The ore being a "chloride" of silver, was crushed dry and amalgamated by the "Boss Process" (which consists in conveying the pulp in a continuous current through a series of pans, where it is intimately combined with quicksilver).

The mine has been developed to a depth of eight hundred feet, the ore occurring in shoots and bunches, and of high grade. The company purpose erecting a twenty-stamp mill to replace the one lately destroyed by fire.

There are several other claims in the district on which large amounts of work have been done, both in shafts and drifts, the most conspicuous being the Perseverance, Dwyer & Gorman, Kohinoor, Cook & Thompson, and the Belle McGilroy, which show a large amount of high-grade ore.

The Keer five-stamp mill has been kept running since 1885, and paying good dividends.

ARROWHEAD DISTRICT

Adjoins the Trojan on the south in T. 9 N., R. 13 and 14 E., S. B. M., and west from Fenner twenty-eight miles. From 1883 to 1887 considerable work was done in the district, several arrastras having been worked by Mexicans on the gold-bearing ores, which yielded from $30 to $50 per ton. The veins have a north and south trend, and can be traced for a considerable distance, the walls being granite and porphyry.

THE NEEDLES DISTRICT,

Situated on the banks of the Colorado River, extends south and west from the town of Needles. The mineral-bearing lodes are numerous, and on some of them a considerable amount of work has been done, the ores being of good grade in both gold and silver. To the west, and back from the river, is a belt of lead ores containing small amounts of silver. Extending south along the Colorado River, for a distance of forty miles, is a strip of country rich in veins, which contain both gold and silver. Fifty miles south from the town, a ten-stamp mill has been erected. The Black Hawk Mine in this region has been worked for some time, the high-grade ore of which has been sold to the Selby Smelting Works at prices ranging from $200 to $400 per ton. More than one thousand tons of ore, that will yield $35 per ton, has accumulated at the mine dumps.

There is a vast extent of country lying adjacent to the river, both to the north and south of Needles, which contains a large amount of mineral.

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SAN DIEGO COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

The mineral resources of San Diego are looking up in every direction since the last reports were made in 1888 and 1889, and the improved condition of the mining outlook then noted has been fulfilled, inasmuch as several of the properties in the Julian and Banner Districts have passed into the hands of capitalists, and are being developed on a large scale and with extensive plants. At present there are sixty-four mining claims duly recorded in the Julian mining records, but a large proportion of these are merely held by doing the required $100 worth of work per annum, without any other thought than to wait for some buyer to come along and take the property off their hands. As Professor Goodyear was through these mines and has thoroughly written them up last winter in the 1889 report of the State Mining Bureau, I shall merely note what has been done since that time.

STONEWALL MINE.

The main shaft, since the last report, has been completed to a depth of four hundred and seventy-five feet, and a new level started; also, in the fourth level, to the northwest, a large body of quartz developed. The twenty-stamp mill that was spoken of in Professor Goodyear's report as being in progress of building, has been completed, and is running steadily, doing excellent work. It is built after the latest designs, everything being compact and convenient. Steam hoisting works have been erected, the gallows frame of the hoist being fifty-six feet in height. The steam engine in the mill is a Hamilton Corliss, twelve by thirty inches; the other is a Marysville slide engine, twelve by eighteen inches. The two boilers are fifty-four inches by sixteen feet. The old ten-stamp mill takes its steam from the new mill.

Elevation above sea level	4,750 feet.
When located	1872.
Dimensions of claim	Claim on Cuyamaca Grant.
Name of nearest town	Cuyamaca.
Direction and distance from town	In the town.
Direction and distance from nearest railroad	35 miles northwest.
Cost of freight from railroad to mine	75 cents per hundred.
Cost of freight from San Francisco to railroad station	50 cents per hundred, in large lots.
Course of vein	Northwest.
Direction of dip of vein	West.
Degrees of dip of vein	80 degrees.
Average width of vein	15 feet.
Formation of walls	Gneiss.
Tunnel or shaft	Shaft.
Formation passed through	Gneiss.
Length of ore shoot	150 feet.
Number of shoots being worked	1.
Greatest length of ground stoped	120 feet.
Pitch of ore shoot	Southeast.
Kind of timber used in mine	Pine.
Cost of timber	$20 per thousand.
Vertical depth of shaft	475 feet.

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Length of levels	No. 1, 400 feet; No. 2, 400 feet; No. 3, 275 feet; No. 4, 800 feet.
Quantity of water coming in	63½ gallons per minute.
Kind of pump used	Knowles & Worthington.
Name of compressor used	Ingersoll; 14 by 24 inches, Class A.
Name of drills used	Ingersoll and Eclipse.
Kind of powder used	Giant No. 2.
Quantity of powder used	1,500 pounds per month.
Amount of nitro-glycerine in powder	40 per cent.
Cost of mining per ton of ore	$1.
Dimensions of shaft	Three-compartment, 17 by 6 feet.
Distance from mine to timber	2½ to 4 miles.
Source of timber	Cuyamaca Ranch.
Distance from mine to lumber	Sawed on the ground.
Cost of lumber	$20 per thousand.
Means of transporting ore to works	Tramway.
Character of ore	Free-milling gold quartz.
Method of treatment	Battery amalgamation.
Description of mills	Two steam mills; a 20 and 10-stamp mill.
Number of stamps	30.
Weight of stamps	750 pounds and 650 pounds.
Drop of stamps	6 inches.
Drops per minute	95 to 100.
Height of discharge	7 inches.
Duty per stamp in twenty-four hours	2 to 2½ tons.
Kind of metal used for shoes and dies	Chrome and common steel.
Cost of shoes and dies per pound	9 cents delivered.
Wear of shoes and dies	70 days when crushing 2½ tons per day.
Battery screens	Slot-cut No. 8.
Dimensions of screen inside of frame	48 inches by 8 inches.
Vertical or inclined	Inclined.
Size of apron plates	4 feet by 9 feet in 3 steps.
Size of plates inside of battery	Back, 10 inches by 4 feet; front, 8 inches by 4 feet.
Copper or silvered plates	Copper.
Inclination of plates	1⅜ inches to 1 foot.
Kind of feeder used	Hendy Challenge.
Percentage of value saved in battery	75 to 90 per cent.
Percentage of value saved on plates	10 to 25 per cent.
Percentage of sulphurets	$\frac{1}{10}$ of 1 per cent.
Nature of sulphurets	Iron and copper.
Value of sulphurets per ton in gold	$250 per ton.
Number of men employed in mine	65.
Number of men employed in mills	8.
Average wages paid per day in mine	$3.
Average wages paid per day in mill	$3 50.
Average wages paid for outside work	$2 50.
Water or steam power	Steam.
Wood used per day for mill	4 cords.
Wood used per day for hoisting and pumping	8 cords.
Species of wood	First-class oak.
Cost of wood per cord	$3.

Developments made during the year consist in the erection of a new twenty-stamp steam mill, and a sixteen by sixty hoisting works. In the mine eight hundred feet of drifts were run on the 412-foot level, discovering an ore shoot one hundred feet long, three feet wide, dipping 80 degrees west. At the distance of one hundred feet another shoot has been struck, three feet wide, the extent of which is not known at present. The mine is ventilated by two air shafts. The distance between the shaft and the new mill is about one hundred feet, and the ore is conveyed by tramway directly into the mill, where everything works by gravitation.

OWENS MINE.

This mine has been putting in a forty-two-inch stroke Cornish plunger pump to enable them to hold the waters which at present are two hundred feet deep. At the time the writer was there they had just finished building the foundation for the machinery. The mine will be run by eastern parties. It comprises at the present time three claims: the Old Owens, the New Owens, and the Jeannette, under the name of the Owens

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Consolidated. The mine is close to the town of Julian. They have a forty horse-power engine. The hoisting machinery consists at present of a fifteen horse-power upright boiler with an eight-inch by sixteen-inch cylinder engine; the rope is seven eighths steel cable. This hoisting engine is to be removed to the San Diego Mine not far off, where it is to be used in hoisting out of a shaft one hundred and fifteen feet on an incline.

Close to the San Diego and abutting the Owens Mine, in proximity to the town of Julian, is the

HIGH PEAK MINE,

Which has been bonded and is being worked on behalf of a company. It is situated in Sec. 32, T. 12 S., R. 4 E., S. B. M. The course of the vein is 80 degrees west of north, and it dips 77 degrees to the east. The people who have bonded are running in several tunnels; one on the ledge is in seventy-five feet, another crosscutting to the ledge is in two hundred and twenty feet to strike it at two hundred and forty feet. The latter tunnel is running nearly due north and south, and will be extended a distance of four hundred feet before completed. If all is found satisfactory a ten-stamp mill will be erected immediately, and the mine run with a night and day shift. This vein is about four feet between walls, of which one and one half is solid quartz.

HELVETIA MINE.

Since this mine, which is in Sec. 12, T. 12 S., R. 4 E., S. B. M., was reported on, an incline shaft one hundred and thirty feet deep has been sunk, for the first fifty feet on a grade of 75 degrees, the remainder straighter. New hoisting works have been erected. The vein is from ten inches to two feet wide. A thirty horse-power link motion engine with seven eighths steel wire cable has been put up. The boiler, which is a forty horse-power locomotive boiler, furnishes the steam likewise for a ten-stamp mill which is being erected. The old original shaft that had been filled up for years is being cleaned out, on which work the parties owning are now engaged; they are down at present forty feet. A forty horse-power engine and boiler and four-inch steam pump are to be erected here. The two shafts are to be connected by drift; about ten feet of the drift have been driven.

THE GARDINER MINE,

Formerly called the Big Blue Claim, has been lately sold to capitalists and will be energetically worked. Since it was reported on, the owner continued his tunnel into the hill to a vein of quartz fifty feet farther than the first one, but running parallel with it, and here he sank a shaft on the vein thirty-five feet, striking some very rich ores. The vein is about two feet wide, dipping about 85 degrees east; an upraise one hundred and thirty-five feet acts as an air shaft.

KENTUCK MINE,

Adjoining the Cincinnati Belle, has been bought with other mines in this district by an eastern company, who are making preparations to

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selves, the process of their restoration being so slow that for all practical purposes it may be ignored.

Waiting on the erosion of the siliceous rocks, the deposition of the gold originally found here has been the work of countless ages. Scanty as it was, eons upon eons have come and gone since it first began to accumulate, nor will a hundred generations see it again sensibly increased.

The examination of these deposits made last year by the Mining Bureau shows that the remnants of them are too low grade to be profitably handled. If the auriferous material left were all concentrated in a single stratum, and it lying on or near the surface, it might possibly be worked to advantage. But under present conditions this would be impossible, as the mass that in working would require to be put through the sluice would not yield half a cent per cubic yard. Nor is this magnetite an easy stuff to wash. More than 72 per cent of it being iron, it settles and impacts in a very troublesome way, a great deal of water being required to carry it through the sluice.

Then the gold being so exceedingly comminuted, it becomes difficult to save the finer portions of it, this being impossible by any mere mechanical contrivance. As a means of more effectually reaching this end, the miners operating here adopted the plan of drying and burning their gunny sacks after removing them from the sluice, the ashes being then collected and the gold amalgamated.

Washing the sacks in the ordinary way would not answer, owing to the manner in which the water held the finer particles of gold in suspension.

But the methods and mechanisms here employed, though as perfect as the average appliance in use, were defective in this: none of them possessed the property everywhere desirable and here indispensable to success, of imparting gold to the sterile material they had to manipulate.

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SAN JOAQUIN COUNTY.

By W. L. Watts, Field Assistant.

San Joaquin County, besides being one of the most important agricultural counties of California, has demanded especial attention of late years on account of the inflammable gas which has been discovered in alluvial formations which constitute her valley lands, and extend in some places to a depth of over two thousand feet; nor are the hills upon the eastern and western sides of the county destitute of mineral wealth.

The natural gas, as will be seen by referring to the tabulated records of the wells hereinafter mentioned, appears to accompany artesian waters in strata of sand and gravel, commencing at a depth of about one thousand feet at the city of Stockton and increasing in volume as deeper strata are reached; the artesian water being incidental thereto, and not the necessary concomitant of the gas.

It appears, that the gas, which is probably emitted from fissures in bituminous rocks underlying the alluvial formations of the valley, accumulates beneath the clayey strata, and, together with the artesian waters, is ever ready to escape at the nearest available opening.

One remarkable feature in connection with the deep wells of the San Joaquin Valley will doubtless be noticed by many readers of this report. It is the great depth below the sea level of to-day at which alluvial formations have been found. In the first Hass well, strata of sand and pebbles were passed through below a depth of two thousand feet, and, as seen in these records, fluviatile deposits have been observed in boring at Stockton, at a depth considerably over one thousand feet; yet the elevation of Stockton above the ocean is only forty-six feet. This will appear the more striking to those who may have observed the numerous evidences of elevation in the hills upon either side of the San Joaquin Valley. Whether a subsidence of land surface and subsequent reëlevation, to a less height, or glacial action is principally responsible for the geological feature referred to, is, from available evidence at the present moment, not very clearly demonstrated; but a scrutiny of the various strata penetrated when boring the deep wells at Stockton, would lead one to regard glacial action as having been, in this instance, the most important agent.

But no matter what the geological methods of the past may have been, the great value of the gaseous fuel that can be tapped from formations underlying the city of Stockton remain the same, especially when her geographical position as a distributing point is taken into consideration.

The rich alluvial lands of the San Joaquin Valley also possess unusual facilities of irrigation, particularly throughout the portion of the country lying upon the eastern side of the San Joaquin River, which territory is traversed from an easterly to a westerly direction by the Mokelumne, Calaveras, and Stanislaus Rivers.

The central, and a large portion of the western side of the county, is watered by the San Joaquin River itself, with its numerous ramifications

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and tributary creeks. As a perusal of the following pages will demonstrate, a good supply of potable water can also be obtained from shallow wells throughout nearly the whole of the county. This is of vital importance, now that the requirements of a rapidly increasing population tend toward cutting up the large ranches into smaller holdings. We will therefore commence our periodical review of the mineral resources of the county by a study of the water supply, more especially as it is derived from shallow wells in various parts of the county.

WATER—FLOWING WELLS.

The area throughout which flowing wells have been obtained in San Joaquin County, seems to be almost entirely confined to the center of the county, and the vicinity of the San Joaquin River; and within these districts, as mentioned in previous reports, the depth at which a good flow can be obtained is about one thousand feet.

In 1889, a well, as mentioned under the head of natural gas, was bored at the Stockton Insane Asylum to a depth of about one thousand and seventy feet. This well yielded, besides the gas, a stream of slightly "mineralized" water, which flowed at the rate of about ninety gallons per minute.

Samples of this water were sent for analysis to Professor Hilgard, of the State University, and Dr. Wenzell, of San Francisco, the returns from whom are as follows:

ANALYSIS BY PROF. E. W. HILGARD.

	Grains per gallon.
Potassium sulphate (K_2SO_4)	1.52
Sodium chloride ($NaCl$)	22.92
Sodium carbonate (Na_2CO_3)	8.97
Calcium sulphate ($CaSO_4$)	.40
Calcium carbonate ($CaCO_3$)	1.30
Magnesium carbonate ($MgCO_3$)	2.51
Silica (SiO_2)	5.20
Organic matter and chemically combined matter	5.02
	47.84

ANALYSIS BY DR. WENZELL.

	Grains.
Solids in U. S. wine gallon	49.870
Sodium chloride ($NaCl$)	23.106
Sodium carbonate (Na_2CO_3)	9.688
Calcium carbonate ($CaCO_3$)	1.314
Magnesium carbonate ($MgCO_3$)	9.653
Magnesium sulphate ($MgSO_4$)	1.238
Calcium sulphate ($CaSO_4$)	1.645
Potassium sulphate (K_2SO_4)	.163
Ferrous carbonate ($FeCO_3$)	.166
Hydrated silica	1.933
Silica	.964
	49.870

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Besides the flowing wells described in previous reports, there is a flowing well on the Grattan Ranch, about four miles northeast from Stockton; this well was bored in 1884 to the depth of one thousand and ten feet. A stream of slightly "mineralized" water of about forty-five thousand gallons in twenty-four hours flows from it; the well also yields some gas. At a depth of nine hundred and ninety-six feet, it is said that the tools suddenly dropped four feet, and that a very strong flow of water came to the surface. At one thousand feet, a bed of "pipe-clay" was struck which was penetrated ten feet. The water flows into a cutting from which gravel was formerly taken, forming a lake about three quarters of a mile long, eighty feet wide, and four feet deep. No stream flows from the lake; the water evidently seeps through the gravel penetrated by the cutting and disappears beneath the ground. This is borne out by the fact, that on another portion of the ranch, about a quarter of a mile north of the well, in excavating for gravel about two years after the well was bored, water was struck at a depth of five feet, while previously it had been necessary to dig to a depth of fifteen feet in that locality before any water could be obtained.

As mentioned under the head of natural gas, all the gas wells in Stockton and vicinity yield large flows of artesian water.

Wells of Stockton.

The city of Stockton is supplied with water by the Stockton Waterworks and numerous private wells. The waterworks obtain their water from three artesian wells which are about one thousand and eighty feet deep, and sixty shallow wells which vary from ninety to two hundred feet in depth. It is estimated that one and a half million gallons are frequently pumped from these wells in twenty-four hours. The private wells are usually less than two hundred feet deep, and most of them less than one hundred feet.

Around Stockton, an abundance of water can be found within one hundred feet of the surface, but the actual water-bearing strata are very irregularly distributed within that limit, exhibiting but little uniformity of depth, until a stratum of water-bearing gravel is reached at a depth of from eighty to two hundred feet, from which the principal supply of water is obtained. Plenty of water is found at a depth of fifty feet, but it is very hard, and although used and considered good by the early settlers, has, after comparison with water from deeper wells, been generally relegated to purposes of garden irrigation. Most of the private wells are cased for the first fifty feet, and then bored to a depth of one hundred feet without casing. The following is an ideal section showing the formations penetrated by the shallow wells:

CHARACTER OF STRATA.	Thickness of Strata, in feet.
Soil	4 to 8
Hardpan	½ to 5
Clay, with small strata of sand and gravel containing more or less water	8 to 140
Beneath the clay water-bearing gravel is penetrated for a few feet.	

The clay is said to be deepest in the northern and eastern part of the city, and that in the northern and western parts the blue clay predominates, while in the eastern and southern portions yellow clay is more

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Character of Strata.	Thickness of Strata, in feet.
Soil	1 to 2
"Cement gravel"	20 to 30
White "pipe-clay"	2 to 3
Cement gravel	40 to 60
"Pipe-clay"	5 to 8
"Cement gravel"	30 to 40
This gravel is sometimes intercalated with white strata, called by well borers "lava," from six inches to two feet in thickness.	
Whitish clay, very dry and "short," caved badly	5 to 6
"Cement gravel"	25
Whitish clay, very dry and "short," caved badly	5 to 6
"Cement gravel"	25 to 40
Whitish clay, very dry and "short," caved badly	5 to 6
"Cement gravel"	25 to 40
Black sand penetrated	30
This sand contains a plentiful supply of excellent water, which rose about forty feet in the pipe.	

In boring through this district, the "cement gravel" would stand alone if it were not for the whitish clay which lies between them. "Clam shells" have been found in some of the strata of "cement gravel."

At the Twenty-eight-Mile House, on Rock Creek, south of Little John Creek, the following formation was observed:

Character of Strata.	Thickness of Strata, in feet.
Black loam	12
Gravel	7
White clayey stratum, called by well borers "lava"	44
Fine gravel and sand	2
Cobblestones	2
Red clay	13
Sand and gravel and a little water	5
Hard clay	7
Gravel penetrated	3

This stratum gave a plentiful supply of water, which rose fifty-four feet in the pipe.

In the southeastern portion of Dent Township, a good supply of water is obtained at from eighty to one hundred and fifty feet. The formation penetrated when boring is as follows:

Character of Strata.	Thickness of Strata, in feet.
Soil, generally gray, sandy loam	15
Hard cement	15 to 20
Grayish clay	4 to 5
Cement	1 to 2
Grayish clay	2 to 3
Strata of cement and light-colored clay two or three feet thick, alternating, for about	40
Sandy loam	40

Beneath the sandy loam is a gravel, which, when penetrated a few feet, yields a good supply of water.

Skirting the foothills north of the Calaveras River, and south of the Mokelumne, the white clays, which are such a prominent feature in the superficial strata between the Calaveras River and the Little John

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In Stockton, the wells completed were as follows: The Stockton Natural Gas, the "Old" Standard, the Northern, the Crown Mills, the Paper Mills, and the Asylum Well. In the county, the Cutler Salmon Well and the Lathrop Well.

The Stockton wells in process of boring were as follows: The Stockton Natural Gas Company (second well), the Stockton Gaslight and Fuel Company Well, the Citizens', the St. Agnes, the Jackson, the Asylum, and the Court House.

There are also several other artesian wells in which inflammable gas incidently occurs, as mentioned in Seventh Annual Report.

The Stockton Natural Gas Company.

This company, with whom, when last mentioned in our report, the question of natural gas was only in the experimental stage, is now in active operation. In 1889 they built a gasometer capable of holding twenty thousand cubic feet of gas; they now report over six miles of pipe laid in the city of Stockton, and are supplying upward of two hundred premises with gas for heating, lighting, and power purposes.

The lamps used for burning the gas are the Wenham and Lungren lamps; these are furnished with regenerative burners, and in both the gas is brought to a high temperature before reaching the point of ignition.

In view of the fact that the gas is odorless, it was deemed advisable by the company to impart to it a smell, to notify the people of its presence, and the company state that this was effected by the following process: The natural gas was heated to a temperature of 500 or 600 degrees, and gasoline and some turpentine vapors were mixed with it in proportion of about half a gallon of gasoline to every one thousand cubic feet of natural gas. This was found to odorize the gas, and, it is said, that in two notable instances serious accidents were prevented by it during the winter of 1889 and 1890.

The writer, who visited the plant and property of this company, found them engaged in boring a new well which then had reached a depth of nine hundred feet. This well is one hundred and sixty feet northeast of the old one, and the strata penetrated by the two wells are similar. It will be very interesting to note, and the company naturally feel very anxious to determine, whether a second well, sunk in such close proximity to the first, will have any effect upon the flow of gas now supplying their gasometer.

Natural gas is used as fuel for the engine with which the company are boring their new well. The twenty thousand-foot gasometer was full, and considerable gas was going to waste from the old well. The writer interviewed several citizens who were using the gas, and they spoke very highly of it as a fuel and for purposes of illumination, especially recommending it for cooking purposes during the summer months. The gas was first used in ordinary coal and gasoline stoves, but with only partial success, the heat not being sufficiently uniform for baking, but proper gas stoves of eastern manufacture are now in more general use. The best results seem to be obtained by the addition of a false bottom to the oven, for which a sheet or two of asbestos is found to be a good substitute.

Several attempts have been made to use the gas for purposes of illumination with ordinary gas jets, and Mr. A. L. Wulff, after several experiments, succeeded in illuminating his store by the use of Argand burners.

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The Jackson Well.

A twelve-inch well has been commenced on the Jackson property in the southern outskirts of Stockton. About six hundred feet have been bored. Flowing water was struck at a depth of five hundred feet.

Gas in the Northeastern Part of the County.

Several years ago, on the Brummel Ranch, near Clements, a dry well was dug to a depth of about one hundred feet, in which it is said the natural gas drove out the workmen.

The Record of Wells Already Bored.

Annexed is the tabulated records of the strata penetrated by the Asylum 1889 Well, the Northern, the Crown Mills, and the Lathrop Wells. The Bureau is also in possession of the records up to date of strata penetrated by several wells now being bored at Stockton, which the courtesy of the well borers have placed at its disposal.

Record of Formations Penetrated by the Well which was Bored in 1889 at the State Insane Asylum at Stockton.

Character of Strata.	Thickness of Strata, in feet.	Depth of Well.
Soil	62	62
Sand, small pebbles, and water	13	75
Yellow clay	23	98
Blue clay	7	105
Reddish sand	6	111
Yellow clay	27	138
Coarse white sand	12	150
Red clay	40	190
Sand and gravel	40	230
Blue clay	13	243
Sand	7	250
Blue clay	21	271
Sand	2	273
Clay	45	318
Black sand	9	327
Blue clay	13	340
Sand	7	347
Blue clay	5	352
Sand	8	360
Blue clay	21	381
Sand	4	385
Clay	112	497
White sand	23	520
Blue clay	45	565
Sand	4	569
Blue clay	111	680
Sand	10	690
Clay	25	715
Sand	9	724
Clay	19	743
Sand	5	748
Clay (flowing water)	32	780
Cemented sand	6	786
Clay	12	798
Cemented sand	2	800
Clay	38	838
Loose black sand	3	841
Clay	5	846
Sand	12	858
Tough clay	72	930
Light blue joint clay	126	1,056
Black sand, mixed with gravel and cement	15	1,071

Flow of water estimated at ninety gallons per minute, and gas estimated at two thousand five hundred cubic feet per twenty-four hours.

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RECORD OF FORMATIONS PENETRATED BY A WELL BORED AT LATHROP IN 1888.

CHARACTER OF STRATA.	Thickness of Strata, in feet.	Depth of Well.
Strata of sand and cemented sand, with occasionally some gravel and cobblestones	590	590
Blue clay	40	630
Sand	10	640
Yellow clay	75	715
White cement	10	725
Yellow clay	130	855
Sand	8	863
Gray cement	12	875
Yellow clay	110	985
Sand	15	1,000
Cement and clay	24	1,024
Sand, gravel, and cobblestones	18	1,042

At this depth, the well yielded about three hundred thousand gallons of water in twenty-four hours, and about three thousand cubic feet of gas.

MANGANESE.

The manganese mine, which for several years has been worked by J. Caire, of San Francisco, is situated on the south side of Corral Hollow, about ten miles south-southwest from Tracy. About two thousand feet of work in tunnels and stopes has been done on this mine, and much ore has been shipped during the last ten years. The working commences in a metamorphic shale, passing into jasper; the harder jasper predominating in the hanging wall, and the more clayey material is in the foot wall. The vein lies at a great angle, and has a general northwesterly and southeasterly course, and varies from a foot to ten feet in width, occasionally opening into chambers. Giant and Black powder are used. The vein, like most deposits of this kind, is irregular; the manganese is of both the hard and soft varieties, and of good quality.

There are several manganese prospects in the hills to the south of Corral Hollow, some of which show good bodies of ore; notably, one opened by Jenkin Richards, on which some work has been done. This ledge is about one mile southeast from that of J. Caire; the formation is similar, with same trend and strike, and varies from one to four feet in thickness.

COAL.

Some prospecting work has been done on Lone Tree Creek, about six miles southeast from Corral Hollow, and also in Corral Hollow itself at an early day.

Near the headwaters of Lone Tree Creek, several feet of coal, mixed with shaly matter, are exposed in the banks of the creek; some work has been done on the vein, but the mine is now filled with water. Farther down the creek work is still carried on. The writer inspected at this point an incline which was being run through shale and sandstone, which dip to west of north at an angle of 40 degrees, on the south bank of the creek. About two hundred feet have been driven on the incline, and it is estimated that about two hundred feet more will have to be run before striking the coal. This property is said to belong to parties in Los Angeles.

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On the north bank of the creek the formation pitches to the southeast at an angle of about 50 degrees.

REDUCTION WORKS.

Dr. J. R. Moffit, formerly of Chinese Camp, Tuolumne County, has erected works at Stockton for the treatment of refractory ores by a new process. The works are on the south bank of the Stockton Channel, so as to command water and also railroad transportation.

IRRIGATION.

There are three irrigation enterprises, which have been undertaken in this county, on two of which work is being actively prosecuted, namely: the San Joaquin Land and Water Company, the Woodbridge Canal and Irrigation Company, and the Mokelumne Ditch and Irrigation Company.

THE SAN JOAQUIN LAND AND WATER COMPANY.

This company, whose works are described under the head of irrigation in Stanislaus County, will extend their canal, as already mentioned, down the Little John Creek into San Joaquin County. Availing themselves to a great extent of natural watercourses, one principal canal will be brought by the way of Farmington towards Stockton, and another canal will be run from the Little John Creek in a southerly direction through Dent and Castoria Townships to Lathrop. The system of irrigation proposed by this company will doubtless greatly enhance the value of the sandy lands in the southern portion of the county.

THE WOODBRIDGE CANAL AND IRRIGATION COMPANY.

This company was incorporated in San Francisco in 1889, their object being to take water from the Mokelumne River, at the town of Woodbridge, and to irrigate a district covering about one hundred and seventeen thousand acres, lying between Stockton on the south, New Hope on the north, and the tide lands upon the west. The water right which is exercised by this company was located in 1885. They have expended some $80,000 in the construction of a canal and a weir across the Mokelumne River. The weir, or dam, across the river is low, the water being generally high enough at this point to supply the irrigating canal without artificial elevation. About two miles had been constructed when the writer visited Woodbridge in the summer of 1890. The canal is sixty feet wide at top, thirty feet at bottom, and is about twelve and one half feet deep at bottom where it leaves the Mokelumne River, decreasing to some three feet in depth where it terminates, about two miles away. Lateral canals will be extended from the main canal towards Stockton on the south, New Hope on the northwest, and Boruck's Landing upon the west. Before the system is completed the main canal will be enlarged to a width of fifty feet, and the lateral canals to thirty feet.

The main canal will divert one hundred and fifty thousand inches of water from the river; below the point of divergence of the lateral

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canals, it will have a fall of six inches to the mile. The estimated cost of this irrigation system is $225,000.

THE MOKELUMNE DITCH AND IRRIGATION COMPANY.

This company was incorporated in 1876. They state that about $30,000 have been expended in surveying and building a portion of their dam and canal. The dam was constructed on the Mokelumne, about twenty-five miles east from Lodi. The fall between the top of their dam and Lodi is estimated at one hundred and forty-five feet. The company propose to divert about thirty thousand miner's inches of water from the river.

In 1887 the company was reorganized, the dam completed, and a portion of their main canal constructed. In 1889, work was suspended in consequence of the available funds becoming exhausted. The dam was injured by the freshets of the winter of 1889 and 1890, and a portion of it carried away. It is said that negotiations are being carried on with parties in England for resumption of the works at no distant day.

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from the Carrisa Plains, but from the mountains forming the southeastern border.

LOS CERRITOS.

Running midway between the Santa Lucia and the coast hills is a unique line of peaks denominated "Los Cerritos" by the Spanish. These are more or less isolated, separated by streams or low passes crossing their course, and standing as a succession of buttes, rising from the southeast of the city of San Luis Obispo and trending northwest, terminating in Morro Rock, a gigantic cone of trachyte in the ocean off Morro Bay, or the "Estero," as formerly called. The largest of these peaks is called "San Luis," one thousand five hundred feet in height, on the northwestern border of the city; "Bishop Peak," one thousand eight hundred feet high, and the highest of the range, "Romualdo," "Cerrito," and San Carlos.

These are chiefly porphyritic trachyte, but bear serpentine about their bases, the smaller hills being almost exclusively of this formation. The trachyte constitutes an available building stone, although very hard chiseling, and can be quarried in as large dimensions as can be handled. The steps of the Court House of San Luis Obispo are made of this rock, and after fifteen years' use the chisel marks of the stonecutter are not worn away. "Morro Rock" being composed of this, and standing in the sea, giving easy and generally safe access to vessels, is deemed exceedingly favorable for furnishing materials for the breakwater in course of construction by the National Government in the bay of San Luis Obispo.

The peaks south of the city of San Luis Obispo are all of less elevation, showing no trachyte, but, according to the traditions of early missionary days, they contained mines of silver from which the "padres" of the church obtained the vast stores of wealth they shipped to Spain. No mines have been found in them during modern times, and the stories attached to the dim and mysterious period are generally scouted, although the hills bear evidence of excavating work having been done.

BUCHON RANGE.

West of Cerritos, and west of Los Osos and Corral de Piedra Valleys, is a range of hills, locally called the Coast Range—a succession of hills —which, if denominated a range, may appropriately be named the Buchon Range, from the principal elevation of the group. In Whitney's Geological Report they are called the San Luis Range, but the names in that report are generally very different from the local names of the present. Mount Buchon is the name in the Coast Survey of the high elevation that rises abruptly from the north shore of the bay of San Luis Obispo. It has an elevation of about one thousand feet, which it carries to the borders of Los Osos Valley, and declines into low sandhills as it reaches Morro Bay. San Luis Creek runs along its southeastern base. See Cañon, a good fruit-growing and farming valley of three or four miles in length, rises in it, running southerly, cutting its northeastern portion. Islay Creek flows from it to the ocean, four miles north of San Luis Bay. The Rancho Pecho y Islay covers the southwestern part of the mountain. In the valley of the Islay are the

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PECHO HOT SULPHUR SPRINGS.

They are used as a bathing resort by many seeking health. In the hills east of See Cañon are mines of chromite, from which many hundred tons of ore have been taken and shipped to the Chemical Reduction Works, of Baltimore. In the same region is a vast body of peculiar iron ore, exceedingly heavy, and stated to be of very high percentage of metal. The general formation is serpentine, with strata of bituminous slates and sandstones running through it, having a trend northwest and southeast, and a dip of about 60 degrees northeast.

South of San Luis Creek but little serpentine appears, the hills being much broken. The formation is bituminous slates and sandstone and masses of sand, like enormous sand dunes of the coast, cemented or saturated with bitumen, and now denominated bituminous rock. Of this material, hills rising to the height of one thousand feet are found extending southeasterly ten or twelve miles, and with a width of range of from one to four miles. These hills are quite detached—streams and valleys between them. The Villa Verde and Pismo Creeks separate hills of the range. In some of these hills the sandstones are saturated with 16 to 18 per cent of bitumen, and in others have cemented the sand into a solid and firm rock, but the volatile oils having evaporated, the rock crumbles to dust under severe blows.

THE VALLEYS.

These, in San Luis Obispo, are many and fertile. West of Santa Lucia is the coast region, a broad area of foothills and valley land, with the specially named valleys of San Simeon, Santa Rosa, Green, Villa, Old Creek, Morro, Chorro, Los Osos, Laguna, San Luis, Corral de Piedra, Arroyo Grande, Huasna, and Cuyama. And east of the dividing mountains are the great valleys of San José or Pozo, Santa Margarita, Salinas, Huer Huero, San Juan, Carrisa, Elkhorn, Estrella, Pala Prieta, Cholame, and those of many streams. The Estrella is one of the large valleys of the east, an elevated plain bordering the Estrella River, and north of it is the similar plain of Cholame.

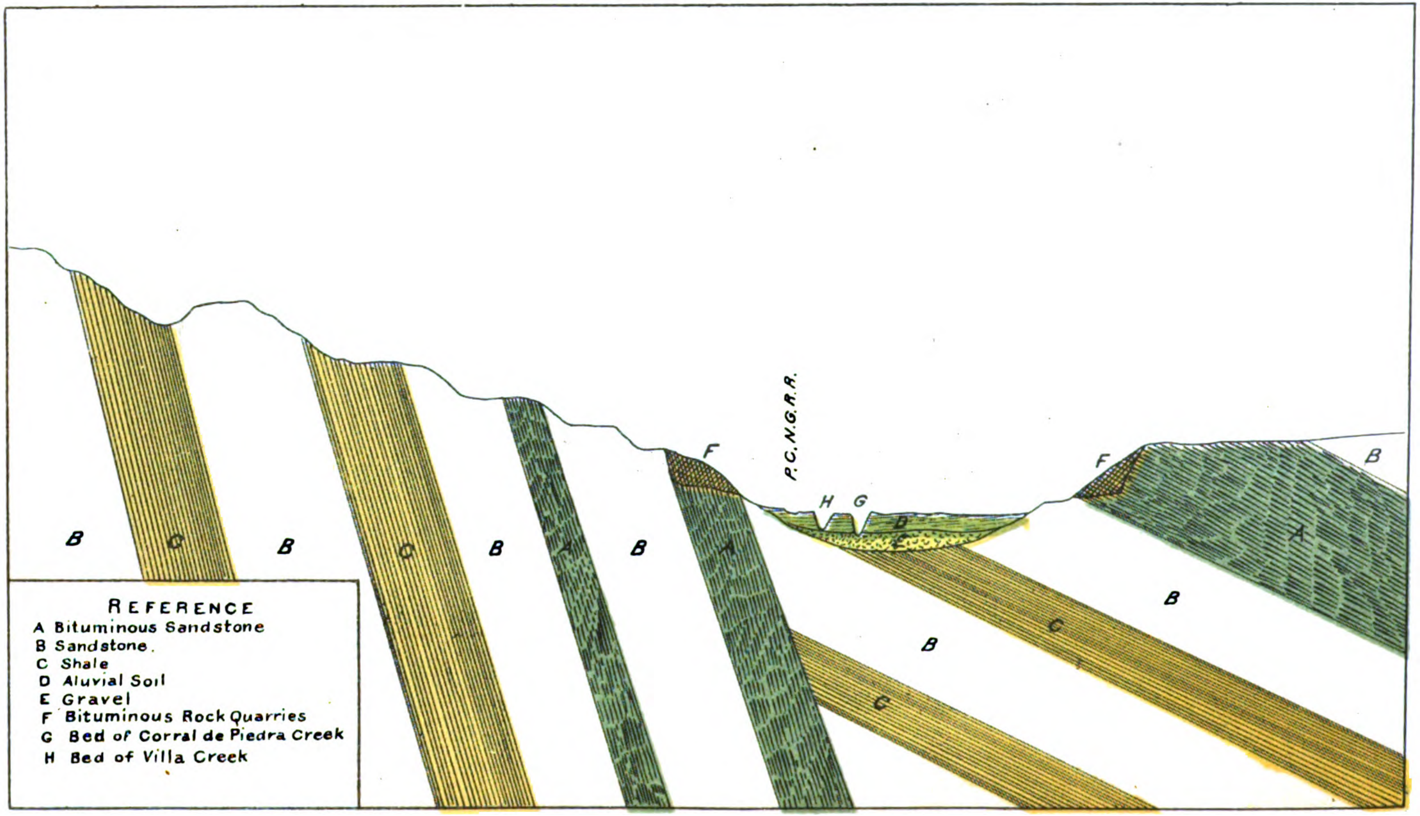
BITUMINOUS ROCK.

Opinions may differ about the correctness of this name as applied to the material in question, but the fact remains that it is known under this denomination.

An analysis of the "San Luis Obispo bituminous lime rock," made by W. E. Judson, of Cleveland, Ohio, for the San Luis Obispo Bituminous Rock Company, gave the following results:

Sand	65.917
Bitumen	16.255
Iron and alumina	8.405
Calcium carbonate	8.212
Magnesium carbonate	1.003
Undetermined	.208
	100.000

The material constitutes a large proportion of the hills bordering the coast from San Luis Creek, near Port Harford, southeasterly five or six



CROSS SECTION AT CORRAL DE PIEDRA BITUMINOUS ROCK QUARRIES Sketch by J. B Hobson. E. M.

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CALIFORNIA BITUMINOUS ROCK COMPANY.

South of the Villa and west of the Verde Creek, near where the two come together, is a high and precipitous ridge of rocks rising some seven hundred feet above the sea. Upon the discovery of the fact that bituminous rock was valuable this ridge was examined and found to be of similar formation as that on the north side of the creek, not a mile away, and a tract of forty acres was purchased by the California Bituminous Rock Company.

South of this property, Mr. C. H. Mero owns a high part of the ridge, which is rich in this material, and on which mining is contemplated.

FRENCH MINE

Is situated on the Neuval Ranch, one of the lots of the Corral de Piedra Grant, about two miles southwest of Edna Post Office, and is being worked at the present time. The opening is in a high ridge of rock having a face of one hundred and twenty feet long and thirty feet in height, disclosing a bed or stratum of about twenty feet in thickness of bituminous matter. At the time of our visit, the company was filling an order to supply sixty tons per day to the Pacific Paving Company, of San Francisco. The company also ship considerable rock to San Diego. Ten men are employed in getting it out. The rock is blasted in large bodies in the usual method by common black powder, drilling being done by hand and churn drills with ease, and at times holes can be bored with an ordinary auger. The rock, however, is tenacious, and requires powder, which greatly facilitates the work of tearing the rock from its natural position and disintegrating it.

THE NEUVAL MINE

Is south of the French Mine and south of Villa Creek, on land owned by E. Bickmore, with John Cisco as Superintendent. Work was commenced in April, 1890, and a body of rock, ten feet in thickness, was disclosed of fine quality. The owner of the land receives a royalty of 20 cents for each ton of marketable ore taken out. This property is on the western slope of the high ridge in which are the mines of the California Bituminous Rock Company and others. In this neighborhood are large masses of gravels cemented by bitumen into a very hard rock which cannot be drilled by ordinary method.

The bituminous rock companies here mentioned are all in a limited area of about one mile, convenient to the Pacific Coast Railroad. North is the large tract of land belonging to the estate of the late J. J. Schieffarley, upon which are several hundred acres of bituminous rock, as also others in the neighborhood, giving every prospect of a practically inexhaustible supply of the materials.

A mile east of the shore, and upon the Pismo Ranch, rises a hill to the height of about three hundred feet, comprising one hundred acres of land, which appears to be a mass of bituminous rock; this has not been developed, and in our examination we found no rock such as is used in paving, but all the surface appeared bituminous. The body of the rock is a fine sand, appearing much like the surface of the rock where

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mum, or one hundred and ten tons minimum, on the block of four hundred and eighty superficial inches, which is equal to a pressure of from four thousand six hundred and twenty pounds to four thousand five hundred pounds per square inch. A sheet of thin paper is placed beneath and on top of the blocks to prevent them from adhering. The blocks weigh six and three fourths pounds, or three hundred to the ton, and are packed fifteen in a box or crate, making a package of one hundred pounds. One man is required to each press, and a boy to carry the conveyer, with a man to weigh into; also, fireman and boxers.

The bituminous blocks are designed for street paving, sidewalks, warehouses, and stable floors, foundations for buildings in wet places, and other purposes.

The owner of the land is to receive a royalty of 10 cents a ton for the bituminous rock used the first year of operations, 15 cents the second year, and 20 cents per ton thereafter.

It is the design of the company to bore an artesian well to prospect for gas or oil. They have found gas issuing in a white sulphur spring three hundred yards above the plant.

CARPENTER OIL WELL.

The land on which this well was bored is lot 64, of the Corral de Piedra Grant, in T. 31 S., R. 12 E., M. D. M., and nine miles south by east from the city of San Luis Obispo. The surface rock is sandstone, generally impregnated with bitumen, and in quarrying it shells and fish bones are found. The formation appears to be an upheaved seabeach, and the hills, ancient sand dunes through which streams of bitumen have percolated.

Hills rise to the height of six hundred feet on the southwest, and three hundred or four hundred feet, a distance of half a mile or more, to the north. Mr. E. Carpenter, noting a flow of bitumen on this land and the finding of petroleum in other parts of the State in similar formations, came to the belief that the same could be obtained in bituminous and asphaltic rocks in this county.

Mr. Carpenter leased this land and commenced boring in August, 1888. His journal states as follows:

From the fifteenth to the eighteenth of August bored fifty-three feet in hard sand rock; August twentieth, penetrated medium hard sand rock forty-seven feet; then struck hard rock, which continued to a depth of twenty-eight feet, when indications of petroleum were obtained. Hard sand rock continued, and at a depth of two hundred and sixty feet a flow of black "maltha," or liquid bitumen, came in, obstructing the boring; this was cased off with six-inch casing, and the boring continued with the five-inch drill. At a depth of two hundred and ninety-five feet bituminous shale was found, which continued thirty-six feet, when hard sand rock was encountered with water; October twenty-sixth, made fifteen feet, of which one was in hard sand rock and fourteen in bituminous shale, producing oil; this rock continued to a depth of three hundred and seventy-six feet, when a stratum of three feet of hard sandstone was penetrated; then bituminous shale for thirty-four feet, and two and one half feet of white slate; then five feet of hard sand oil rock; then fifteen inches of white slate; then for fifty-four feet in bituminous shale, producing water and gas in small quantities. December twenty-eighth struck hard sand rock at a depth of four hundred and eighty-six feet.

At this time it being necessary to procure new tools, and the capital not being available the boring was discontinued. Water with some bituminous matter continues to flow from the well, but not of sufficient quantity to be of material value.

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GOLD.

Traditions say the missionary fathers obtained large quantities of gold silver, and lead from mines within the region of this county. When Mexico became independent, and the priests left for Spain, they are reported to have taken vast amounts of treasure with them.

There are traditions of rich silver mines which were concealed by the "padres," and the secret of their locality and workings confided to Indians, under the threat of punishment if ever disclosed. As extensive mining excavations cannot be concealed, the stories of vast wealth must be regarded as only an alluring bait. The gold mines, while having yielded considerable, and capable of yielding more, give no evidence of having been worked sufficiently to greatly enrich the missionary fathers. Gold and silver were obtained to some extent in the period prior to the occupation of the country by the Americans. A relic in possession of the Dana family, of San Luis Obispo, is a bill of lading of the date of October 22, 1826, in which is mentioned as part of the cargo of the brig Waverly, Captain W. G. Dana, four bars of silver, weight, five hundred and twenty-six marks and five ounces, and one lump of gold, weight unknown. Where this gold and silver was mined is unknown.

Gold is found in the sands of the ocean beach, both in Santa Barbara and San Luis Obispo Counties, and in ledges in places in the mountains of the interior. The earliest record published of gold mining in San Luis Obispo is in the report of the Pacific Railroad Survey, by Lieutenant J. G. Parkes and Dr. T. Antisell, in 1854, saying "that a party of native Californians were washing gold in the San Antonio, in the northern part of San Luis Obispo County, and making $4 a day each." A slight error in name or locality, as the San Antonio is in Monterey and not in San Luis Obispo County; but gold mining was conducted upon the San Marcos Creek and others of the western slope of the Santa Lucia at an early day. Dr. Antisell remarks upon the distinct ranges or geological formation as the Santa Lucia and the San José, the latter having a granitic basis, and in this range the gold is found.

LA PANZA MINE.

The section most distinguished for gold mining in the county is on the eastern slope of the San José Range, and known as the La Panza District, taking its name from the ranch and stream upon which the principal mining has been done. This stream flows northeast towards the San Juan. These mines have been worked in a small way for an unrecorded period, and at one time two hundred and fifty people were washing gold in the neighboring gulches and creeks. Mining was prosecuted quite energetically for two or three years, during which time it was estimated that $100,000 worth of gold was taken out. The miners in those times made from $2 to $4 per day, generally washing the gold-bearing earth in pans and rockers, and in a few instances using sluices. No hydraulics were used, or machinery of any kind. In this manner, but constantly diminishing in numbers, mining continued, till at present but little is done, and the amount of gold extracted does not exceed $1,000 a year. The gold-bearing country is quite extensive, but water is scarce, and it is distant fifty or sixty miles from any town. Veins of gold and silver-bearing rock are reported existing in the range, one

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quite rich in quicksilver is found upon the limits of the city of San Luis Obispo. One is on the property of P. H. Dallidet, near Santa Rosa and Islay Streets, and in 1872 was worked to some extent, and with crude apparatus considerable quicksilver was obtained. The vein is in low land of the valley, in the serpentine rock; and much water coming in, required pumping in order to prosecute the work to any depth.

Thus it will be seen that the quicksilver interests of San Luis Obispo are of great importance, there being vast quantities of valuable ore. Throughout an extended region the cinnabar is found much scattered over the surface, also bodies found deep in the earth. Ores were mined which gave from 2 to 20 per cent quicksilver.

Elements for great prosperity in this class of mining are found here, and the home interests of mining are justly appreciated and permitted to rise to that elevation which naturally belongs to them; as is shown in the history of the world, the mining interest will be developed, and all business will then prosper.

CHROMIUM.

Throughout the Santa Lucia Mountains and the coast hills of this county are found serpentine rocks with beds of chromite in greater or less masses, existing as loose and fragmentary rocks in the ravines and on the hillsides, and as pockets and veins on the mountains. The ore is collected and mined to a considerable extent in this county, and shipped to the chemical reduction works at Baltimore and Philadelphia, from a few hundred to three thousand tons of 50 per cent ore being sent forward annually. Much of this has been picked up from the surface of the ground upon public lands by laboring men, and the balance mined by an indifferent system. The standard price paid for ore at the shipping point of San Luis Obispo is $8 per ton for ore of 50 per cent chrome, and higher rates for richer ore. This rate does not give much profit to the mine owner, although it pays good wages to the miner or prospector. The principal purchaser is the Kaolin Chemical Company of Baltimore. The cost of transportation and other attendant expenses raises the cost upon delivery in Baltimore to $22 50 per ton. Ore from Scotland costs, at the company's works, $25 per ton. Many deposits of this valuable ore have been mined in this county, but the records of their product are meager, excepting such as are owned by the Kaolin Company. This company, about 1880, obtained possession of a number of mines, chiefly on public lands, on Chorro Creek, on the western slope of the Santa Lucia, and on land adjoining Chosse grant.

Of these the Colorado, located on Sec. 25, T. 29 S., R. 10 E., worked in 1881 to 1883, yielded three hundred tons.

Las Amigus, on the same section, yielded in 1881 eight hundred tons.

La Flor, in same vicinity, in 1881 yielded eight hundred tons.

Rodilla, in same vicinity, from 1881 to 1883 yielded five hundred tons.

Arroyo de la Rodilla yielded one thousand tons.

Estrella, on Sec. 26, in 1881 to 1883 yielded two thousand tons.

Lone Pine, on Sec. 35, with two tunnels of three hundred feet each, has produced several hundred tons, and has a large quantity of low-grade ore on the dump, from which the high grade has been assorted.

Morro vein, opened by tunnel, produced in 1883 fifty tons.

Guadalupe, in the same vicinity, opened by tunnels in 1885, produced one hundred tons, and much good ore still in sight.

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Santa Theresa, in 1882 and 1883 shipped sixty tons.

Loudon, half mile south, in 1882 and 1883 shipped four hundred tons.

New Magdalen, Old Magdalen, Soledad, and others produced good ore, but the amount is not recorded.

Little Salto, float ore in bed of Chorro Creek, about half of the underlying rock being ore, shipped in 1883 one hundred tons.

Kaolin Mine, about one mile south of preceding, in 1883 shipped fifty tons. Large body of ore in sight in tunnel.

The Kaolin Company purchased and shipped in March, 1890, six hundred tons.

One of the best opened mines of the neighborhood is the Pick and Shovel, which is located on the South Fork of Chorro Creek, at an elevation of one thousand eight hundred feet. This mine is opened by two tunnels, one of three hundred and the other of nine hundred feet in length, with drifts. From this mine about five thousand tons of high-grade ore, exceeding 55 per cent, have been taken out, and the mine is still profitably worked.

The mines of the Kaolin Company have not been worked since 1883, and appear to have been abandoned, and as they are on public land are now subject to relocation.

Quite a number of the chrome mines of the vicinity have been purchased under the mining laws of the Government by Goldtree Brothers—of those patented, El Devisadero, El Salto, Primera, La Trinidad, and Castro. The amount of ore taken from these mines is not recorded. They have not been very extensively worked, but are awaiting the erection of beneficiating works in this region, or an enhanced price for the ore.

In the coast hills west of and four miles distant from the city of San Luis Obispo, is the Jasper Mine, which has been worked at intervals for six or seven years past, and about two hundred tons taken out, being a fine quality of ore.

There are many other bodies of chromite in the county, the quantity being abundant and the supply apparently inexhaustible. In view of the abundance of this valuable mineral in this county, and the cheap rates at which every necessary material can be purchased for converting it into the valuable pigment, it appears to offer a most inviting field for enterprise to establish beneficiating works. This is the opinion of Prof. H. G. Shaw, late Superintendent of the Kaolin Works, of Baltimore, and under his management the organization of a company was undertaken in 1890, and at the close of this report had every prospect of success.

DIATOMACEOUS EARTH.

On the Rancho Corral de Los Mulos, on the eastern slope of the Santa Lucia Mountain, and on Sec. 23, T. 26 S., R. 10 E., M. D. M., is a large deposit of infusorial earth that was put on the market in 1880 under the name of "Magic Polish," by a company organized for that purpose, an analysis of which gave the following:

Silica	70.23
Alumina	16.55
Lime	1.06
Magnesia	.59
Potash	11.32
Undetermined	.25
	100.00

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The inclosing rock is sandy slate, the ledges of onyx standing nearly perpendicular, and having a thickness of about sixteen feet. In the middle of the vein, at the present southern opening, is a fissure of about ten inches broad and of unknown depth, as small stones dropped in go rattling for some time, and at last are heard to strike water in the depth of the cavity.

Near the summit of the hill, on the line of the vein, is a spring of medicinal water flowing about half a barrel an hour. The water has a pleasant salty taste, is a strong purgative, and is very effective as a wash in curing cutaneous affections. No analysis of the water has been made.

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SAN MATEO COUNTY.

By W. L. Watts, Field Assistant.

San Mateo County, which occupies nearly the whole of the peninsula terminating in the city and county of San Francisco, is traversed throughout its entire length by a continuation of the Santa Cruz Mountains.

As is the case with Santa Cruz, secular elevation has given the county upon its northeastern and western boundaries a strip of comparatively level land, in the raised beaches, which lie between the mountains and the shore line of to-day.

The mountains of San Mateo present very similar features to those observable in Santa Cruz County. The bituminous formation crops out at several points, and the granitic rocks are quite prominent upon the western side of the county; indeed, they can be traced from the precincts of Santa Cruz to a short distance southeast of Point St. Pedro, and near the latter place, notably upon the Deniston Ranch, they afford very fair samples of syenitic granite.

Farther inland, the Mount Diablo series of rocks are developed, and the eastern ridge of mountains exhibits various gradations of metamorphism, conspicuous among which, at some points, are serpentinous and jaspery rocks, the latter being sometimes traversed by tiny veins of quartz, as is frequently the case among the more highly metamorphosed shales of the Coast Range.

At some points, basaltic rocks have been observed, and on the San Gregorio Rancho, the Field Assistant of the Bureau noted and obtained specimens of vesicular dolerite, the vesicles of which were filled with petroleum. The only mineral industry developed to any extent in San Mateo County, are the oil wells of Purissima and Tunitas Creeks, and the storage of water by the Spring Valley Water Company; although considerable prospecting for coal, cinnabar, and the precious metals has been undertaken in the county.

PETROLEUM.

The principal petroleum interests of San Mateo County are centered at present in the Tunitas and Purissima Cañons. The wells of the Tunitas and Purissima Districts were leased in 1888 by Mr. C. M. Cook. In that year he sank a well on the O'Brien Ranch, in the Tunitas Cañon, to the depth of six hundred and forty feet; this was completed in September, 1888. This made the third well bored on the O'Brien Ranch. When first bored, three barrels of oil were pumped from this well every twenty-four hours. This yield continued for three months, when it gradually decreased to one and one half barrels. The specific gravity of this oil was 0.49 to 0.50. Mr. Cook then moved his machinery into the Purissima Cañon, and bored a well on the Wilson Ranch to the depth of five hundred and sixty feet. Oil was struck at sixty-four feet. Work was continued until a depth of five

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which, commencing in its northern corner, skirts the inner edge of the salt marshes of the San Francisco Bay to a point between San Mateo and Redwood City; then, turning inland, it cuts through the western limits of Redwood City and enters Santa Clara County to the southwest of Menlo Park. A short distance before reaching the latter place it is joined by another artesian area, which, commencing in the valley lands of the Cañada de Raymundo, probably extends in an easterly direction, following the course of the San Francisquito Creek towards the confines of Santa Clara County. Throughout the greater portion of this area—indeed throughout the whole of the first mentioned district—flowing water can be obtained by boring; as might be supposed, the strongest flow at the least depth, with some few and rather curious exceptions, is obtained in the marsh land upon the margin of San Francisco Bay, and in the bay itself. Away from the marshes, the strongest head of artesian water is between Menlo Park and Mayfield, and Redwood City. As Menlo Park and Mayfield are approached, however, the water-bearing strata appear to lie deeper than at the county seat. In several places springs boil up in the bay; one very large one is situated about a mile southeast of Hunter's Point, and from it fresh water has been obtained by means of a tube.

There are several wells bored in the bay for persons engaged in the oyster beds; one two miles northeast of Millbrae is one hundred and sixty-five feet deep, but does not flow, while about three quarters of a mile from Millbrae there is an eight-inch well one hundred and eighty-four feet deep, which flows from a pipe seventeen feet above the water at high tide.

There is a flowing well about two hundred feet deep five miles east of San Mateo, and another three miles east of Belmont Landing which is two hundred and fifty feet deep.

The strongest well in the bay is situated near Ravenswood, about one and a half miles from the shore. When first bored, it threw up sand and gravel with the water. It flows from a pipe over thirty feet above the water at high tide. The bay at this point is about fourteen feet deep at high tide, and five feet at low.

At Menlo Park, all the flowing wells are east of the railroad track, the farthest inland being about two miles from the marsh, notably upon the Flood Ranch, where there are two flowing wells. On Mr. Stanford's estate there are six or seven bored wells from two hundred to seven hundred feet deep; but although an inexhaustible supply of water can be obtained from them by pumping, none of them are flowing wells.

The formation observed when boring to a depth of over three hundred feet on the Stanford estate was as follows:

Character of Strata.	Thickness of Strata, in feet.
Soil	10 to 15
Yellow clay	40 to 60
Loose coarse gravel	8 to 10
Stiff yellow clay	20 to 30
Clay and bowlders	170

At Fair Oaks, a little over a mile from Menlo Park, on the Burney estate, a well was bored two hundred and fifty-four feet deep, which flowed from an eight-inch pipe two and one half feet above the ground;

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These are all flowing wells. During the summer months water is pumped from them for sixteen hours per day, during which time they yielded about ninety-six thousand gallons. After pumping, the wells usually cease to flow for about an hour, but this season, *i. e.*, 1890, for only about a half an hour. The pumping also seems to affect wells on the east side of Redwood City Creek, west of the salt marsh. At the time the deep well was bored for the City Waterworks, considerable interest was excited, owing to the fact that quartz was struck which was said to contain silver, and also an auriferous sand. The Field Assistant of the Mining Bureau made diligent inquiry with regard to this well. He found some of the citizens of Redwood inclined to the belief that it was "salted," and others claim that such was not the case. He interviewed S. Haley, of San Francisco, who bored the well, and that gentleman stated, that if the well was "salted" he knew nothing about it, and he was quite certain the quartz rock could not have been, which he passed through for sixty-seven feet.

He stated that the formation penetrated in boring the well in question was as follows:

Character of Strata.	Thickness of Strata, in feet.
Adobe	4
Yellowish porous "joint" clay, with surface water	14
Bluish sand	122
Whitish, milky colored clay	2
White calcareous stratum	3
Gravel and sand, with flowing water	10
Tough yellow clay	12
Grayish blue clay, tough and hard	44
Serpentine rock	100
Quartz, said to contain gold and silver	67
Hard grayish rock	62

He says that he has bored several wells in Redwood City, and upon the marsh between that city and the bay, and that the formation for the first two hundred feet has corresponded with that observed in boring the well for the City Waterworks.

Towards the bay, the flow of water increases. In that direction there are good flowing wells at the brewery, and at the tannery at the edge of the marsh; there is also a good flowing well at the old fish house at the mouth of Redwood City Creek. Of course, owing to local causes, there is frequently more or less departure from the typical section of water-bearing strata. Thus, in a well recently bored in the eastern outskirts of Redwood City on the property of W. Hughes, the following is a record of the various strata passed through:

Character of Strata.	Thickness of Strata, in feet.
Soil, black adobe	3
Yellow clay	4
Gravel, with surface water	23
Yellow, interstratified with blue clay	45
Sand and gravel, with water	1½
Tough grayish clay	92
Quicksand and gravel penetrated	2

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This stratum contained a good supply of water, which rose to the top of the well. Wells bored in the marsh land are said to be frequently much affected by the rise and fall of the tide.

Westward from Redwood City, the area of flowing wells, as far as has been developed, appears to be confined to the marsh land bordering the bay, to the bay itself, and a few exceptions of instances towards the northern extremity of the county. A well was bored in Wellesly Park, about one and a half miles west of Redwood, to a depth of about eighty feet, before a supply of water was obtained. After passing through fifteen feet of clayey soil, a stratum of gravelly clay was penetrated, which was sixty feet in thickness; beneath the clay, loose bowlders were encountered. This stratum yielded a supply of water, but gave much trouble in boring.

The town of San Mateo obtains its water supply from the Spring Valley Waterworks and from surface wells.

The wells, which have been dug to the depth of twenty-five or thirty feet around the town, yield an abundant supply of surface water. The soil is from ten to twenty feet thick, beneath which is a water-bearing gravel; this the wells usually penetrate for some fifteen or twenty feet.

South of San Mateo Creek the land is a little more elevated, and the wells average perhaps ten feet deeper.

West of the town of San Mateo the wells are also deeper; on the Parrott Ranch, about one mile from the foothills, a well was bored to a depth of three hundred feet. The boring was nearly all the way in rock.

About twenty-five years ago a well was sunk near the railway depot to a depth of eighty feet; twenty-five feet of soil were passed through, and the gravel penetrated for about sixty feet. The water rose to within thirty feet of the surface, and practically an inexhaustible supply could be obtained by pumping.

At the Howard Ranch, which is reclaimed marsh land, about a mile southeast of San Mateo, thirty wells were bored, varying from twenty-five to one hundred and twenty-five feet deep, and one which was three hundred and forty feet deep. They flowed fifty thousand gallons every twenty-four hours during a dry season, and during a wet season upwards of one hundred thousand gallons.

These wells are situated within an area of a few square miles, and within a distance of two miles from the edge of the bay, yet there is a lack of uniformity in the volume of water they yield that is somewhat remarkable. Some of them are greatly affected by the tide, and others much less so. Thus, some of the wells rise from ten to fourteen inches above the ground at high tide, and at low tide they cease to flow. The well nearest the bay, which is about five hundred feet from high-water mark, is only forty-seven feet deep. It flows ten inches above the ground at low tide and twenty inches at high; while one which is close to the San Mateo Creek, and only eight hundred feet distant, is one hundred and twenty-seven feet deep, but it only flows six inches above the ground at high tide, and at low tide it ceases to flow. The one farthest west is ninety-six feet deep, but it does not come within three feet of the surface. The total cost of boring and casing these wells was about $3,000.

From a comparison of the various borings, the following is an ideal sketch of the strata passed through.

Vertical sketch of strata on Howard Ranch:

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SANTA BARBARA COUNTY.

By MYRON ANGEL, Assistant in the Field.

The major portion of the county is composed of hills and mountains, the latter high, rugged, and precipitious, of insufficient explorations to fully determine their character and resources.

The lower hills are usually arable and the valleys fertile. The eastern part of the county is a mass of mountains of confused formations, as well as nomenclature.

The Sierra Nevada Range from the north sweeps in a curve through the southern part of Kern County to the southwest and abuts against the formations of the Coast Range. About the terminus appears the nucleus of a system of ranges to the various points of the compass north, west, and south. The San Emidio is a short spur extending into the Tulare Valley. The Monte Diablo reaches far to the north, the Santa Lucia to the northwest, the Sierra Madre del Sur, the San Rafael, and Santa Ynez are projecting ridges extending into Santa Barbara County; and on the south are the Piru and other mountains. The center ridge has been pronounced by the Geological Survey a later formation than the Sierra Nevada, a more recent upheaval. Peaks rise to the height of seven thousand to eight thousand feet, and the mass of the mountain is from four thousand to six thousand feet above the sea in its eastern part, with arms of two thousand to three thousand feet elevation. Prospectors have penetrated portions, possibly the greater part of the wilderness region; but of it, generally, little is known. The Santa Ynez is the most conspicuous arm of this system in the county, extending west from the main body seventy miles, where, after falling into a succession of low hills, it sinks into the ocean at Point Arguello with a branch southerly to Point Conception. Santa Ynez is a precipitous ridge, rising to the height of four thousand feet, and having a base of about six miles in width. The mass of the mountain appears of stratified sandstone, with very sharp dip to the southwest. There are no evidences of minerals of value in the formation. The south face of the range is quite bare of vegetation, but the northern slope is covered with chaparral and oaks. On the northern side are benches and spurs covered with enormous sandstone bowlders. Beneath the San Marcos Pass, and in the opposite cañons leading thereto, is the surveyed route of the Atlantic and Pacific Railroad, which, ascending from the southern side, attains an elevation of about one thousand four hundred feet, and pierces the mountain with a tunnel of about two miles in length. From the southern base to the sea extends a fertile section with a width of four miles. In this plain the city of Santa Barbara is located.

At the northern base of the mountain runs the river Santa Ynez. This river rises in the mountains on the eastern border of the county, receiving many streams on its course, and empties into the Pacific twelve miles west of the town of Lompoc, after a course of about eighty miles.

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that in June, 1889, the waves carried off all the barren sands of the beach, leaving about an inch of black sand rich with gold. He collected all that he was able to at every low tide, and at every high tide the rich deposit was renewed. Soon another storm returned the barren sand and the "bonanza" was covered to a depth of six feet. He believes the gold comes from the ocean, but the general opinion is that it has come from the breaking down of the bluff by the waves beating against it. The owners of the claims report they are enabled to make but from $1 to $5 per day to each person engaged, wages being $1 50 per day and board for white men, and $1 per day without board for Chinamen.

In the long stretch of beach, gold is found in several localities from Point Pedernales to Point Sal, twenty miles. It being so disseminated, it is difficult to obtain in such amounts as miners desire.

The depth of sand and gravel on the beach is unknown.

One of the miners assured the writer that he knew of a vein of platinum, but as it was on granted land, he would not divulge the locality.

On the Hilton Ranch are found beds of ochre, from which paints of good quality are made. The colors are blue, yellow, and red.

Santa Maria Valley, like the other valleys of this county, appears to have been a deep estuary of the ocean, now raised and filled with detritus from the mountains to an elevation a little above the sea level in its lower portion, and rising to two hundred and fifty feet in its eastern portion.

An artesian well was sunk in the town of Santa Maria to a depth of two hundred and eighty feet in sand and gravel without reaching bedrock or obtaining flowing water. Water for the town of Santa Maria is obtained from wells about sixty feet deep; the water being pumped by steam power by the use of asphaltum for fuel, which is obtained about four miles distant in San Luis Obispo County at a cost of $4 per ton. This bituminous material carries a large percentage of sand and gravel, and is said to be much more economical than wood, one ton of which being equal to two cords of live oak wood.

There is also much asphaltum in the hills north of the Sisquoc.

The Cuyama Valley has loose, sandy soil in its lower portion; in the upper portion it is more compact and susceptible of a high state of cultivation. In this region are some powerful hot springs. Soda and sulphur springs are reported; also, vast beds of gypsum forty feet in thickness, covering large areas, remarkably pure and brilliantly white, well adapted for the production of plaster.

The geology of the county shows the predominance of bituminous formations inclined at a high angle.

At Summerland, four miles east of the city of Santa Barbara, a well was bored. At three hundred and fifty feet a flow of gas was struck, which, from a two-inch pipe, showed a pressure of forty pounds to the square inch. This gas burns with a bright flame visible for many miles.

GYPSUM.

For many years large quantities of gypsum have been mined in the northwestern part of the county. This enterprise has been fully described in the report of the State Mineralogist for 1888.

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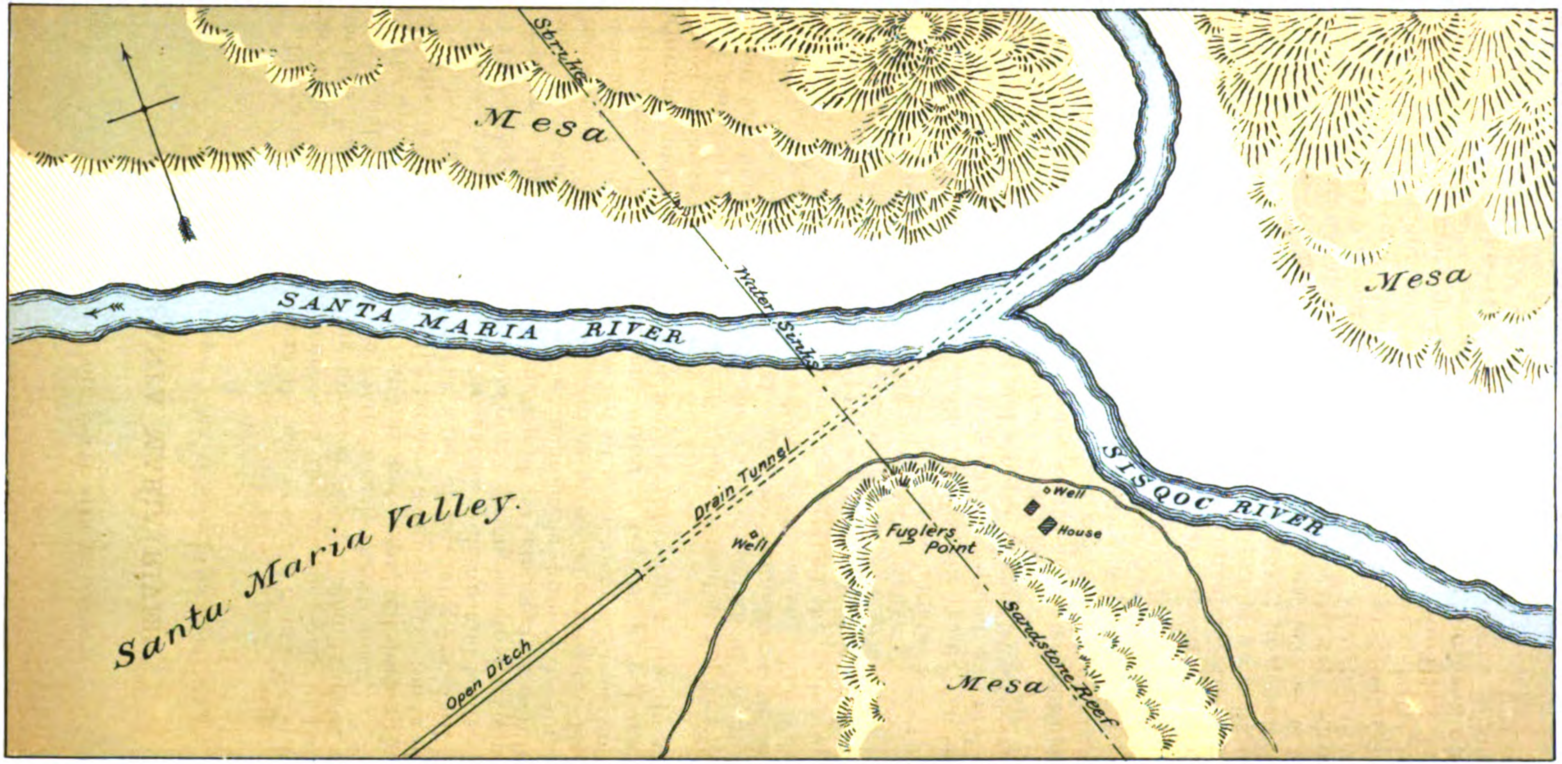
PLATE I



SANTA MARIA RIVER AT FUGLERS POINT Sketch by J. B. Hobson. E.M.
Showing Sink of Santa Maria and Drain Tunnel for Development of Water for Irrigation.

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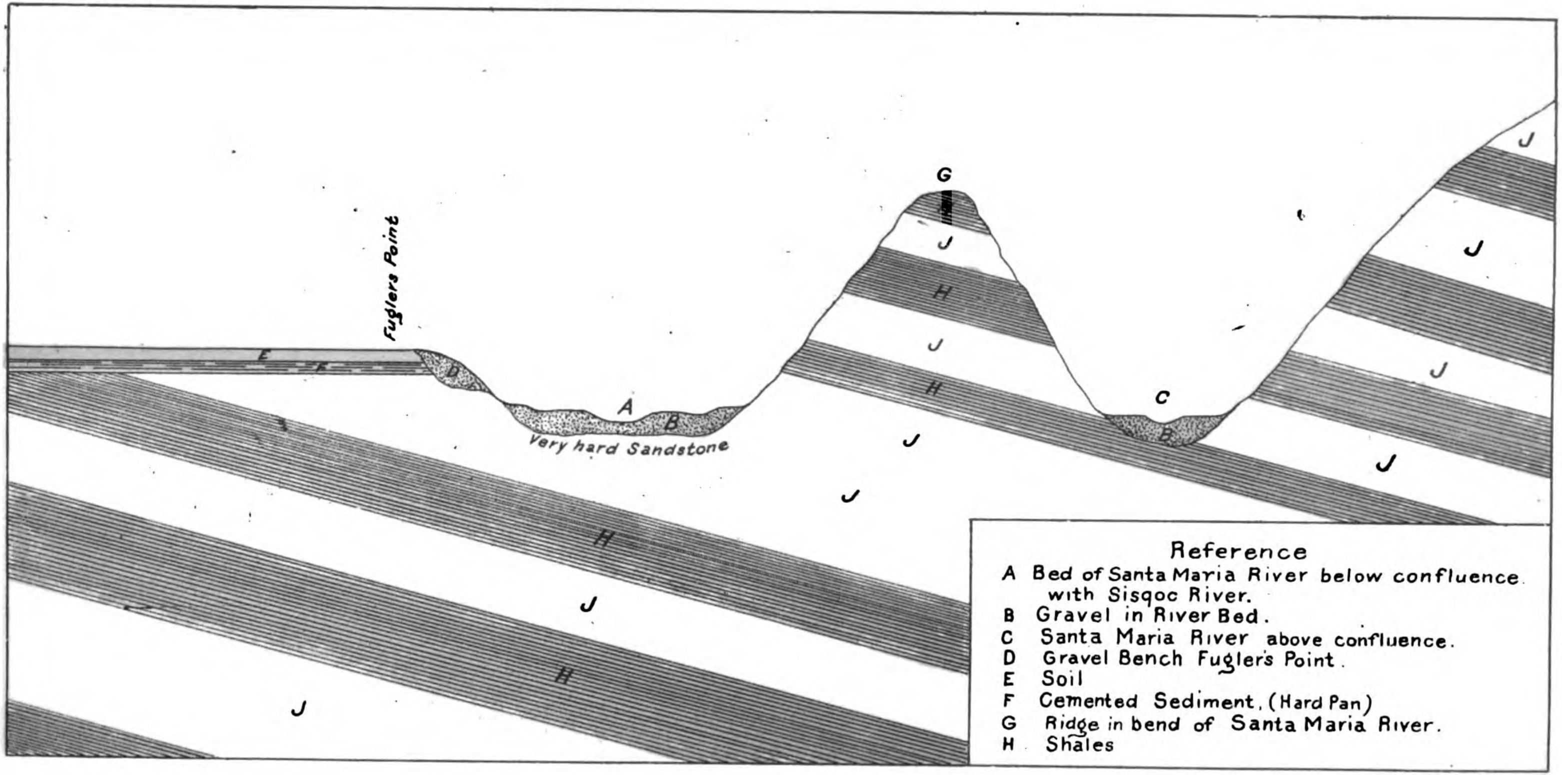
PLATE II.



CROSS SECTION AT FUGLERS POINT SHOWING GEOLOGICAL FORMATION. Sketch by J.B.Hobson. E.M.

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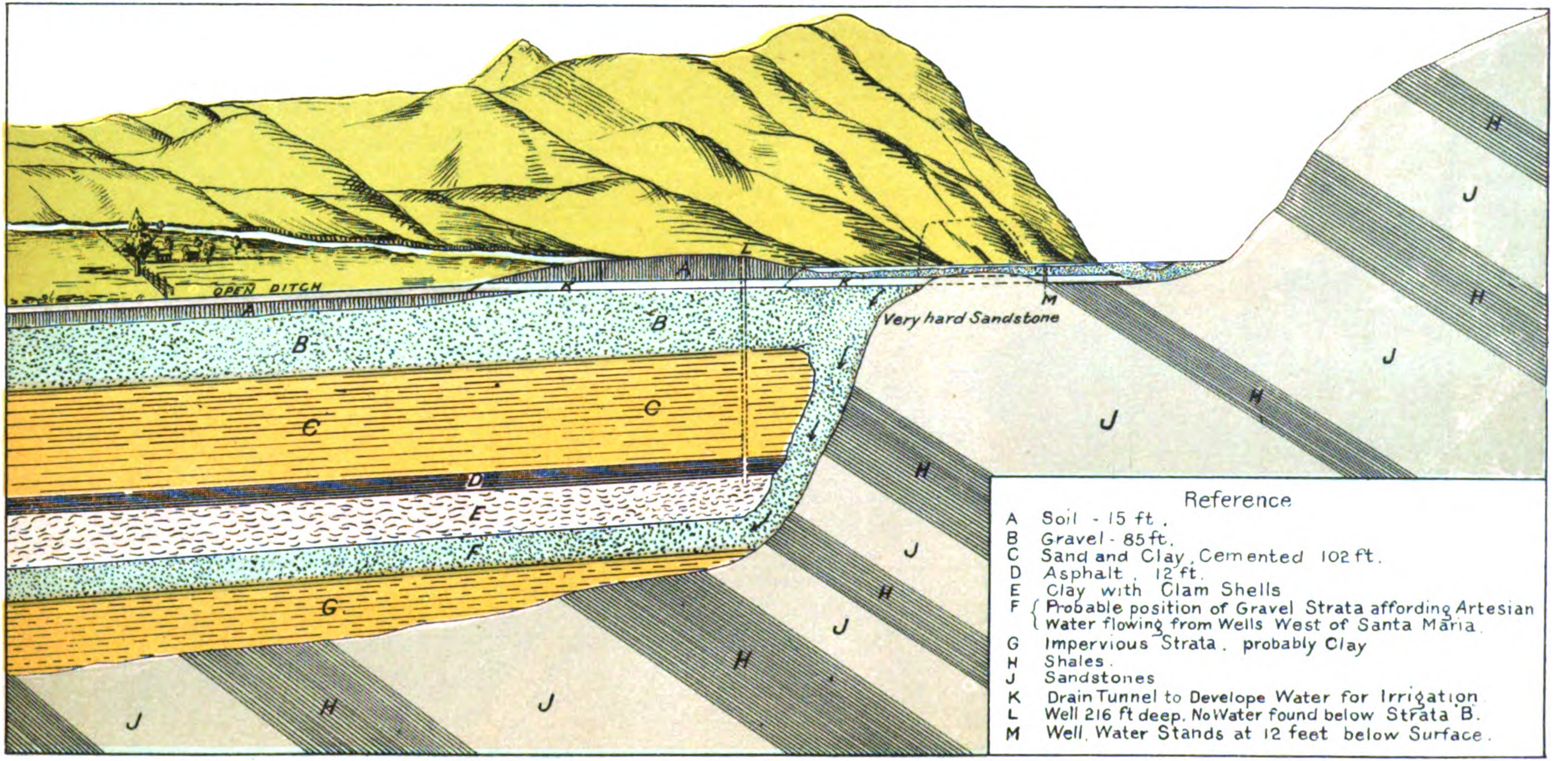
PLATE III.



SECTION ON LINE OF DRAIN TUNNEL AT FUGLERS POINT. Sketch by J. B. Hobson. E. M.
Showing Geological Formation at the Sink of the Santa Maria River.

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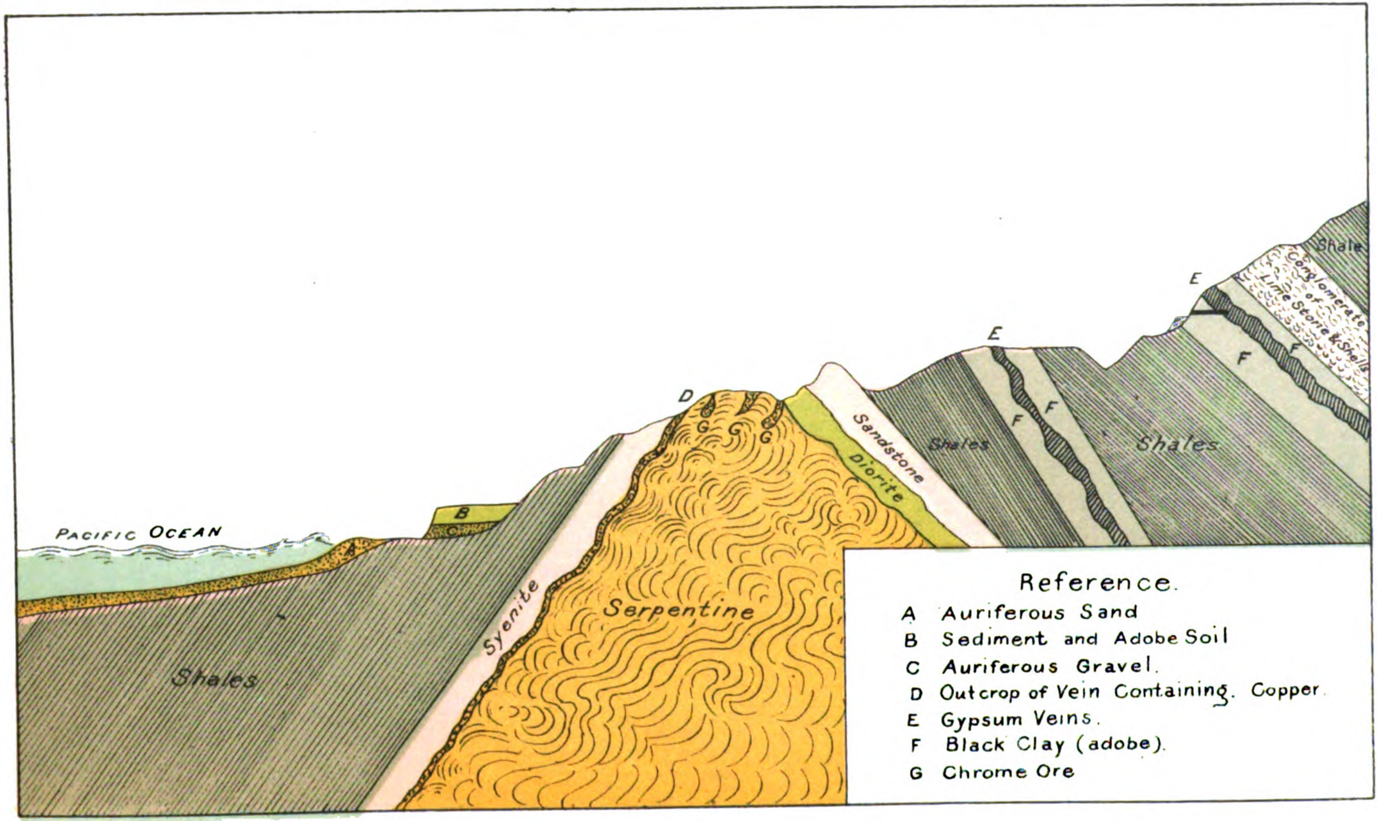

CROSS SECTION SOUTH OF POINT SAL. Sketch by J. B. Hobson E. M.

Showing Geological Formation at Casmalia Gypsum Mines.

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pounds. When lighted, the flame burned with a bright yellow light, and extended about eight feet into the air. The flame gave no smoke, showing perfect combustion.

A syndicate of Santa Barbara and San Luis Obispo capitalists was then formed for the purpose of developing the find. The Ortega Rancho was leased, boring machinery moved on the ground, and operations were begun on a ten-inch well. This well was put down four feet from the first two-inch well. Gas was again struck from the grass roots down. The following is a description of the strata:

Character of Strata.	Thickness of Strata, in feet.
Dry adobe soil	2
Dry adobe soil finely impregnated with crystals of sulphur	10
Light-colored blue clay	10
Blue shale clay of a darker color	9
Gas.	
Coarse sharp sand	6
Blue shale clay	7
Gas.	
Coarse sandrock, or compact sand stratum, with bowlders	35
Gas.	
Hard sandrock	13
Gas.	
Blue clay shale	4
Chocolate shale impregnated with oil	8
Total	104

In the above description of strata the word "gas" shows only where flows of an extra pressure were encountered. As was stated above, gas was encountered and was flowing in the well from the surface. At times the pressure was so great that mud and dirt were thrown from the well forty feet or more into the air.

The actual amount of gas flowing from the well is difficult to determine. In King's "Treatise" it is estimated that a pipe ten inches in diameter and five hundred yards long will carry 47,655 cubic feet per hour if the gas is under a pressure of two and a half inches water pressure. The pressure in the above well is equivalent to many times two and a half inches of water pressure. A conservative estimate would place the flow of gas from the well at over two million cubic feet per day of twenty-four hours.

This is undoubtedly the largest flow of gas ever developed at so shallow a depth; and the well stands to-day, in all probability, the only well of the kind in the world. In the Eastern States gas is found in quantity only at a great depth. But it is well to bear in mind that the stratification in their oil-bearing and gas-bearing sections has been but little disturbed. The strata lie practically horizontal, and in the exact position in which they were originally formed. In California, on the other hand, it may be said that almost no stratum lies in its original position. The whole State has been subjected to violent upheavals, and the strata are standing more or less on end. If the gas-bearing strata in the Eastern States had been subject to violent upheavals, and, in consequence, one end of the strata came up near the surface while the other end dipped into the bowels of the earth, the Eastern States would undoubtedly have gas wells as shallow in depth as the Summerland.

The position of the well is most advantageous, it being less than one

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SANTA CLARA COUNTY.

By W. L. Watts, Assistant in the Field.

Santa Clara County, the geography and topography of which has been described in previous reports, although largely made up of rich farming land, vies with any other county in the State of California in matters of mineralogical and metallurgical interests.

Santa Clara is divided from San Mateo and Santa Cruz Counties, by the watershed which separates streams emptying into the bay of Monterey from those flowing into the bay of San Francisco. Parallel to this ridge towards the east, is a lower tier of mountains in which the New Almaden Mine, so fully described by Mr. Becker, of the United States Geological Survey, is situated.

This lower ridge is composed of rocks which vary from the most highly metamorphosed to unaltered fossiliferous strata. Mr. Becker also found that eruptive rocks were represented by the occurrence of rhyolite in the vicinity of the New Almaden Mine, while basalt formations were reported by the Field Assistant of the Mining Bureau in 1889 upon Coyote Creek, in the neighborhood of Madrone Station.

The mountains to the east and northeast of Santa Clara County for the most part present less evidences of metamorphic action than is observed upon its western borders; and in many places unaltered strata of great thickness form dry, desolate ridges, greatly worn and eroded by the action of the elements, their exposed surfaces in the summer time being frequently coated with alkaline efflorescences.

As the mountains on the eastern edge of the county trend toward the south, metamorphic rocks are more abundant, the unaltered strata giving place to jaspers and serpentines. This district is a rough, inhospitable region, which would require much time and labor to thoroughly investigate. Farther to the south, unaltered strata of both the Cretaceous and Tertiary formation make their appearance.

QUICKSILVER.

The geology of the quicksilver formations, and the industry so extensively developed in the portions of the county in which they occur, have been so exhaustively treated upon by Mr. G. F. Becker and Prof. S. B. Christy, that with regard to the New Almaden District it would be superfluous for the Mining Bureau to do more than record statistics given by the New Almaden Quicksilver Company. From papers put at the disposal of the Bureau by Mr. J. B. Randol, it appears that the output of the New Almaden Mine for 1888 was eighteen thousand flasks; during that year the highest price per flask was $48, and the lowest $37, the average being $42 50.

The output for 1889 was thirteen thousand one hundred flasks, the highest price for that year being $50, and the lowest $40, the average being $45 per flask.

In the bulletin on the quicksilver industry, issued by the New Alma-

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In the opinion of the borers, the oil at this depth was about to flow when the tools were lost; they have not yet been recovered. The word "shell" is a technical term amongst oil men for a hard siliceous stratum usually overlying oil-bearing strata.

In November, 1889, another well was commenced a short distance to the southeast of No. 9, this making the tenth well bored on the Moody Gulch oil property:

STRATA PENETRATED BY WELL NO. 10.

Character of Strata.	Thickness of Strata.	Depth of Well.
Soil	55	55
Shell	1½	56½
Small amount of oil.		
Brown shale	73½	130
Black shale	45	175
Fifteen gallons of oil were bailed out.		
Brown shale	120	295
Black shale, full of grit	195	490
Small amount of oil.		
Brown shale; small amount of oil	6	496
Brown shale; small amount of oil	4	500
Brown shale	100	600
More oil.		
Brown shale	75	675
Brown slate	25	700
Black slate	35	735
Thin shell of quartz, with oil.		
Black slate	40	775
"Shell"	2	777
Good showing of oil.		
Black slate	4	781
Brown "shell;" coffee-colored	47	828
Gray "shell"	46	874
Brown shale and thin, hard stratum of "shell"	83	957
Brown slate	43	1,000
Shell (more oil)	80	1,080
Gray "shell" and sand, followed by more oil	80	1,160
Gray "shell"	50	1,210
Gray "shell"	19	1,229
Gray shale	21	1,250
Gray shale, mixed with "shelly" strata, and more oil	165	1,415

BITUMEN.

The bituminous deposits and springs in the southwest corner of Santa Clara County occur in the foothills forming the eastern slope of the Santa Cruz Mountains. They are principally developed upon the Sargent Ranch, about three miles from Sargent Station, on the Southern Pacific Railroad. They are more or less distributed over about sixty acres, although the principal outcrop of the bitumen-soaked strata are confined to an area of a few acres, within which most of the tar springs occur. At this point the shales are light in color when not stained with bitumen, and resemble those in the foothills upon the western side of the Santa Cruz Mountains. A tunnel has been run for a short distance in this formation, but it now has caved in. The shales are overlaid by sandstone. About one hundred and fifty feet lower down the mountain, and distant perhaps half a mile, are several tar springs exuding from a serpentine formation, and upon the opposite side of the ravine from that upon which they occur, a well was bored some four years ago to a depth of about seven hundred feet.

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running southeast from the last named point to the neighborhood of the Twelve-Mile House.

Experiment has demonstrated that practically an inexhaustible supply of well water can be obtained by boring throughout the whole of this area, with the exception of the San Juan Bautista Hills and the Lomas La Grimas. The portion of the above described area, within which flowing wells may be obtained, may be regarded as bounded by lines drawn from Milpitas and Mayfield to San Jose, the area extending into the bay of San Francisco. In a general way, it may be said that this district is bounded by the bay of San Francisco upon the north, the Oakland and San José Railroad upon the south and east, and the San Francisco and San José Railroad upon the south and west. Within this smaller area flowing wells can be obtained at a depth of three hundred feet, and frequently much less, with the exception of the neighborhood of Alviso; and a good supply of surface water is generally found at a depth of from ten to twenty feet. Upon the outside of the area of flowing wells the depth of surface water increases, until, as the hills are approached, a depth of one hundred and twenty-five feet or more has to be reached. Outside of the area of flowing wells, the superficial formations are very irregularly stratified, and are generally gravelly loam or sand, separated by gravelly clay, containing stones and bowlders, which increase in size towards the mountains. Within the area of flowing wells the stratification is said to be more regular, strata of clay, generally from five to one hundred feet in thickness, being separated by gravelly strata, usually from three to fifty feet, but sometimes one hundred feet thick, and sandy strata of from one to twenty feet.

From many of these strata, lying sometimes at a depth of about three hundred feet below the surface of the ground, and much below the tide level of to-day, organic remains of terrestrial origin have been obtained, which refer to the time of their deposition to Quaternary periods. A notable instance was a "bear's tooth," which was found in the last stratum penetrated when boring a well on the ground of Captain Aram, about one mile north of San José, the said stratum being two hundred and fifty feet below the surface of the ground, while other mammalian remains were obtained from a well on the Varney Ranch, on Coyote Creek, at a depth of two hundred and seventy-five feet; also, from a well on the Stockton Ranch, about one mile from the center of San José, at a depth of one hundred and forty feet, and from many other places.

Wood has been frequently brought up from artesian borings, in Santa Clara County, notably from a redwood stump or log, which was bored through at a depth of one hundred and ninety-three feet on the Cullan Ranch, about half a mile from the Court House, at San José. On the Broughton Ranch, about two and a half miles west, and three and a half miles north of San José, a stratum of wood and clay, the wood preponderating, was bored through for forty-one feet, the stratum extending from a depth of one hundred and sixty-two feet to two hundred and three feet below the surface of the ground; and about two miles north of Alviso, on land belonging to the California Investment Company, a boring penetrated wood for five feet at a depth of thirty-five feet beneath the surface.

Marine organisms have also frequently been met with. "Oyster shells" were obtained in a stratum of bluish sand, encountered at a depth of one hundred and ninety-four feet on the land of the California

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Well on Cullan Property at San José.

Character of Strata.	Thickness of Strata.	Depth of Well.
Sandy clay	45	45
Gravel	10	55
Sand	8	63
Sand, cemented with clay	3	66
Loose gravel	22	88
Yellow clay	6	94
Blue sandy clay	14	108
Gravel	10	118
Yellow clay	6	124
Sandy clay	25	149
Quicksand	4	153
Gravel	9	162
Three quarters of an inch flow of water.		
Whitish-yellow clay	6	168
Sand	24	192
Redwood stump	1	193
Clay	11	204
Sand	12	216
Cement	2	218
Gravel	9	227
Three quarters of an inch flow of water.		
Clay, sand, and gravel	12	239
Loose gravel	2	241
One inch flow of water.		
Clay		

Well on Rutherford Ranch, Three Miles North from San José.

Character of Strata.	Thickness of Strata.	Depth of Well.
Loam	20	20
Blue clay	33	53
Gravel	18	71
Blue clay	13	84
Gravel	57	141
Sandy clay	15	156
Sand	24	180
Cemented gravel	5	185
Gravel and water	5	190
Blue sandy clay	30	220
Blue clay	38	258
Yellow clay	14	272
Cemented gravel	4	276
Gravel	69	345
Blue clay	35	380
Yellow clay	8	388
Quicksand	4	392
Gravel	4	396
Gravel	22	418

Water flowed two inches above surface of the ground.

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WELL OF THE CALIFORNIA INVESTMENT COMPANY, ON MARSH LAND NORTH OF ALVISO.

CHARACTER OF STRATA.	Thickness of Strata.	Depth of Well.
Salt peat bog	10	10
Blue clay	6	16
Red clay	8	24
Blue clay	22	46
Quicksand	9	55
Gravel	24	79
Yellow clay	11	90
Blue clay	37	127
Sandy red clay	14	141
Blue clay	24	165
Hard blue clay	9	174
Bluish sand and oyster shells	20	194
Gravel	4	198
Hardpan (clay and gravel)	3	201
Gravel	2	203
Blue clay	3	206
Yellow clay	4	210
Blue clay	6	216
Blue sand	7	223
Gravel	17	240
Red clay	2	242
Sand	2	244
Blue clay (very hard)	6	250
Yellow clay	8	258
Blue clay	12	270
Quicksand	6	276
Gravel	13	289
Yellow clay	1	290
Gravel	26	316

Water flowed one and a half inches above the surface of the ground.

The shallowest flowing artesian wells in this district are about sixty feet deep; there is said to be one of that depth on the Minter Ranch, about one mile north of Santa Clara, and at several places in San José. Many of the artesian wells in San José and Santa Clara have of late years ceased to flow during the summer months, except after very wet seasons. Several wells in the eastern part of San José, on the west side of Coyote Creek, which afford flowing water, cease flowing when the large windmill pumps between Coyote and Evergreen are working. As a general rule greater depth has now to be reached in this vicinity before flowing water can be obtained than was the case several years ago.

As Alviso is approached the water-bearing strata lie deeper, and the depth at which flowing wells can be obtained is more uncertain. It is said that in 1887 a well was bored on the Moses Parsons Ranch, near Alviso, to a depth of seven hundred and thirty-five feet before a good supply of flowing water was obtained.

It is the opinion of well borers, that the water-bearing strata near Alviso contain less water than they do at points midway between San José and that place. The strongest flows of artesian water at the least depth are said to usually be obtained throughout the district lying between Santa Clara and Milpitas. A well is said to have been bored about seven years ago on the Dixon Ranch, some three miles north of Milpitas, to a depth of four hundred feet, and that no flowing water was obtained, although the surface water was reached at a depth of four feet. Outside of the area of flowing wells, but within the larger area before described, throughout which an abundant supply of water can be obtained

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SANTA CRUZ COUNTY.

By W. L. Watts, Field Assistant.

Almost the whole of Santa Cruz County is traversed by broken chains of mountains, which culminate in the more lofty portions of the Santa Cruz Range, abutting the Loma Prieta tier of mountains upon the confines of Santa Clara County, the latter ridge being distinguished from the mountains farther to the westward by the extent of its metamorphism and the frequent occurrence of quicksilver ores.

The mountains throughout Santa Cruz County are for the most part either clad with a dense growth of timber and chaparral, or covered with alluvial soil yielding an excellent pasture, which, on account of the proximity of the ocean, remains green long after the grazing lands of the interior are parched and dry.

Along the coast line (except in the northwestern corner of the county, at which point the mountains come down nearly to the water's edge) a series of raised beaches form a strip of more elevated land along the seashore. This widens to the south of the city of Santa Cruz and affords a large area of fruitful soil, which has been brought into a high state of cultivation.

The rocky formation throughout this more level strip seldom presents any signs of metamorphic action. The strata are frequently found resting horizontally and conformably upon one another, or nearly so, while farther inland the evidences of metamorphic action increase, and so does the disturbance of the strata. In the southern end of the more level strips of land referred to, are the deposits of auriferous sand described in report of 1888. In the foothills to the northwest of the city of Santa Cruz are the bituminous rocks, also described in previous reports, and the record of the industry connected therewith for the two years ending September 1, 1890, is hereto appended.

Farther inland, with the exception of the Stribling Gold Mine, the lime industry, the brick kilns of Mr. F. A. Hihn, and some quarries of local importance, the mineral wealth of the county is at present undeveloped.

As one follows any one of the mountain ranges inland, the evidences of geological disturbances become more and more apparent. Unaltered sedimentary strata, frequently upturned at a great angle, occur in close proximity to those that have undergone both physical and chemical changes; while here and there, as a distinct range in a northerly direction from the city of Santa Cruz, granite rocks are found which may be regarded as axial rocks of the Santa Cruz mountain system.

BITUMINOUS ROCK.

Since the last report of the State Mineralogist, there has been a continuous and steady increase in the demand for the Santa Cruz bituminous rock, as an inspection of the statistics of the different mines

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will demonstrate. Besides the continued demand from San Francisco, many interior towns, which heretofore have doubted the advantage of bituminous pavement, have adopted it for their best streets. As might be supposed, the varieties of bituminous rock that contain the least amount of the lighter petroleums are found the best adapted to the wants of the interior towns, where a higher rate of temperature exists than upon the seacoast. Only the drier variety of bituminous rock is now shipped to the interior of the State.

This industry was greatly impeded by the continuous rains during the winter of 1889 and 1890; indeed, work was virtually suspended from the first of November, 1889, to the first of March, 1890. During the latter part of 1889, previous to the commencement of the heavy rains, the companies were working a very strong force, intending to get two or three thousand tons of bituminous rock for winter use; but the rains, commencing as they did with such severity and nearly a month earlier than usual, resulted in a shortage, which, although it detracted from the output during the winter of 1889–90, caused an increased demand upon the quarries during the summer of this year. To avoid as much as possible a repetition of hinderance from wet weather, the bituminous rock companies propose opening a new road which will greatly facilitate the hauling. The new road will be shorter and of easier grade.

The Board of Supervisors have directed the County Surveyor and two appraisers to make the necessary surveys and appraise the damage to the properties it is proposed to traverse. Should the projected road be built, the bituminous rock quarries will, no doubt, be kept open during the winter months. There is also talk of a railroad to connect the quarries with the Southern Pacific Railroad at Santa Cruz.

Nearly all the bituminous rock hitherto placed upon the market comes from the quarries of the Consolidated Bituminous Rock Company, whose rock is handled by the Pacific Paving Company, of San Francisco; from those of the Santa Cruz Rock Paving Company, or the quarries of Williams & Garrat. The latter quarries have been recently leased by the Consolidated Bituminous Rock Company. A new quarry has been opened upon the property of Henry Cowell & Co., who have shipped rock during this summer to San Francisco and elsewhere. The statistics for the above mentioned firms for the year ending September 1, 1889, are hereto annexed. Several other new openings have been made in the bituminous rocks of Santa Cruz County; notably, upon the ranches of Messrs. Wilder, Silva, and Speroni, which are situated to the west of Santa Cruz City; but no large quantities of rock have yet been taken therefrom.

Amount of Bituminous Rock Taken from Quarries of the Santa Cruz Rock Paving Company, for the Two Years Ending September 1, 1890.

September 1, 1888, to August 31, 1889	5,709 tons.
September 1, 1889, to August 31, 1890	7,497 tons.
Total	13,206 tons.

Amount of Bituminous Rock Taken from the Quarries of the Consolidated Rock Paving Company, for the Two Years Ending September 1, 1890.

September 1, 1888, to August 31, 1889	6,412 tons.
September 1, 1889, to August 31, 1890	5,093 tons.
Total	11,505 tons.

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down by the creeks from the sand of the ancient sea beaches, which are now raised, in many cases, several hundred feet above sea level, and extend a long way inland; indeed, almost to the base of the Santa Cruz Mountains. The Field Assistant of the Bureau found Mr. Raymond using a Woods & Garcelon single pan machine by way of experiment.

In the machine seen working, the sand was fed with a shovel into a hopper, into which a stream of water ran from an inch pipe. A slot screen, with slots one quarter to three quarters of an inch in dimension, screened out the coarse gravel. The sand was washed through a discharge pipe into a circular pan. This pan was a double one, consisting of an outer and inner pan. The inner pan was shallow, circular, and made of copper, the surface of which was silvered and coated with mercury; it was suspended within an outer and deeper copper pan, the surface of which was also silvered and amalgamated. This double pan was supported by a spider, which was suspended by four chains from cross-pieces at the top.

The water and sand flowed down upon the inner pan. The spider sat loosely upon a cam, the weight being borne by chains with which the spider was suspended. Thus, by the revolution of the cam an eccentric motion was given to the pan similar to that of a pan worked by hand. The cam was bolted to a disc by a bolt, the position of which regulated the throw of the pan according to the character of the material to be worked. The disc was supported by an upright shaft, and received its motion from a parallel shaft with miter gear. Nearly all the gold was caught on the inner pan, very little showing in the outer one, and the writer could find none in the tailings. Mr. Raymond stated he had considered his results so satisfactory that he had ordered a larger machine to be constructed.

Messrs. Wood & Garcelon say that a six-pan machine, with capacity of six tons per hour, can be run by a half-horse-power engine, and that the machine would only require from five to six hundred gallons of water per hour.

Messrs. Jesse Cope and Garcelon, of Santa Cruz, state that at the beginning of 1890 they paid a visit to the ranch of P. Leonard at San Andreas, where previously an unsuccessful attempt had been made to work the auriferous black sand contained in the ancient raised beaches, which at this point lie between the mountain and the present shore line. They took with them one of Messrs. Wood & Garcelon's machines. They found that the Sweitzer tunnels, described in report of 1888, had caved in, and, consequently, they could only obtain sand much mixed with barren material. They put through two sample lots of about one ton each. From one lot they obtained $1 65 in gold, and from the other $1 03. This Leonard property is now bonded to Messrs. Cope & Garcelon, who state that they have made numerous experimental borings in order to discover the extent of the auriferous sand.

The Field Assistant of the Bureau encountered Messrs. Garcelon and Reeves at San Andreas, who had spent several days prospecting the black sand on the Leonard Ranch. They bored a series of prospect holes over a distance of fifteen hundred feet south of the Sweitzer works, and they state that in many places they struck black sand showing several colors to the horn. They say that they bored about twenty two-inch auger holes, averaging from twenty to thirty feet deep. After passing through various shallow strata of clay, sand, and gravel, at a depth of about

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twenty feet, they usually struck the "sand capping," which overlies the deposits of black auriferous sand at San Andreas. This sand capping is a stratum of clayey sand largely composed of the black sand containing the gold.

Messrs. Garcelon and Reeves say that a "prospect" could usually be found at a depth of twenty to thirty feet below the surface. They experience, however, considerable trouble from water, for after an unusually wet season, like that of 1889 and 1890, water is struck in this locality wherever a stratum of clay is penetrated. Water was also found on the top of the sand capping before mentioned. Whenever water was encountered, as may be supposed, but little sand was brought up by the auger. As a result of their borings, Messrs. Garcelon and Reeves are of the opinion that the deposit of sand is the thickest slightly to the east of the old works. The auriferous sand of San Andreas is about two hundred feet above the sea level.

GOLD QUARTZ.

Work has been prosecuted irregularly on the Stribling Gold Mine during the last year. He ran his mill for a short time upon a few tons of rock, which yielded at the rate of $97 50 per ton, and he considers it the best ore ever crushed in his mill. Subsequently the mill was moved a little farther down the creek, in order that an experimental run might be made upon rock from openings at that point. During the winter of 1889 and 1890 the operations were much hindered by water, which, during the prolonged rains, drowned out the workings. In spite of these disadvantages he ran his mill at intervals and cleaned up some two or three hundred dollars.

During the current year, parties intend opening new workings on the north end of Mr. Stribling's farm, about fifty rods northwest of the old mine, at a point where croppings have been found that assay $50 per ton.

In the near future, Mr. Stribling proposes building a larger mill. The one he has hitherto used has a capacity of only one ton per day, and although good enough for prospecting purposes, on account of its small capacity he restricted milling operations to the richest ores; and it is thought he can find work for a five-stamp mill of five hundred pound stamps. A mill of this size will enable him to work ore of a lower grade than he could hitherto handle to a profit.

Many specimens of rich float rock have during the last year been discovered around Ben Lomond, but no new ledges have been struck.

WATER.

Santa Cruz is about to have a great accession to its water supply by the completion of a new reservoir, which will contain sixty-five million gallons. It is to be situated about two miles from the center of the city, upon the Cowell Ranch, at a height of forty-three feet above the level of the greater part of the city of Santa Cruz. The reservoir will be supplied by water from the Laguna Creek, the headwaters of which are about ten miles away. The water will be brought by a fourteen-inch wrought-iron pipe.

The Laguna Creek rises amongst the granitic rocks of Ben Lomond.

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and passes through the old town of Ono, which is situated seven miles distant; and can be traced from here to Watson Gulch, a distance of about twelve miles; and from there to Parks' store, about eight miles; and from there to Arbuckle. The channel is distinctly seen on the top of Arbuckle Mountain, which has an elevation of three thousand feet above sea level; from here it takes a short bend and runs in a westerly course to Knob Gulch, and can be traced up this gulch for a distance of ten miles. Knob Gulch was very rich in both places where the channel crossed it. All traces of the river bed disappear when we reach the Chauchalula Mountain. This range is covered with a conglomerate gravel. After leaving here, we see nothing more of the ancient river bed until we reach Hay Fork, in Trinity County; from there it takes its regular course and passes through Humboldt County, and empties into the Pacific Ocean at Gold Bluff.

At Texas Springs, which is three miles west of Clear Creek Station, on the Oregon and California Railroad, is an immense deposit of sandstone, in T. 31 N., R. 5 W. The trend is northeast and southwest, and lies almost horizontal. It is about nine hundred feet in width and about twenty miles in length. The rock on the surface contains many beautiful specimens of fossils. About one hundred yards north of the sandstone belt we come into large deposits of auriferous gravel which have been worked, but are now exhausted; these deposits were very rich. The gravel is covered in many places from ten to fifteen feet deep with clay. It is a clay formed from decomposition of a granite rock, but it has too much quartz and feldspar and decomposed mica, with some magnetic sand. After washing out all these, the clay sticks to the tongue and becomes blue when acted on with the blowpipe, in the presence of cobalt solution. In Oregon Gulch we again encounter deposits of this same clay matter covering the auriferous gravel. Parties are sinking shafts here, endeavoring to bottom the supposed ancient river bed.

SOIL AND PRODUCTS.

The soil of the valleys is alluvium or sediment containing some disintegrated rock or gravel. It has a light red, or a reddish brown color, and produces the very best quality of plums, pears, figs, and all small fruits. The bench lands are not good for grain, but for vines and fruit they are especially adapted. On the foothills the red loam predominates, which is very productive for timothy and clover. The average rainfall is thirty-six inches; but last year, from June 1 to May 1, 1890, the rainfall was 63.67 inches. This, however, was an unusually wet year throughout the State. It is claimed that irrigation is not necessary in this county.

The county is well supplied with valuable timber land, consisting principally of sugar and yellow pine. This timber extends the entire length of the county, following the mountain ranges on both sides east and west.

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MINES AND MINING.

OLD DIGGINGS DISTRICT.

Texas and Georgia Mines.

According to official survey, this property is located in S.E. ¼ of Sec. 33, T. 33 N., R. 5 W., M. D. M. It has an elevation of one thousand four hundred feet above sea level. The average width of vein is about eight feet. It has a northeast direction and dips to the southeast. This property is being opened by tunnels. No. 1 tunnel is about two hundred feet from the surface; it is three hundred feet long. No. 2 tunnel was started eighty-four feet below No. 1, and driven in three hundred and eighty feet. No. 3 tunnel, one hundred and twenty-two feet below No. 2, is now in five hundred and eighty feet; the management are still driving this tunnel forward. The width of ore in this tunnel varies from one to ten feet. The vertical depth reached from surface in No. 3 tunnel is about five hundred and forty-one feet. The face of this tunnel is in good ore. No. 4 tunnel is located about one hundred feet below No. 3. The face of this tunnel is about one hundred and eighty feet from the mouth; it is expected that it will have to be driven fifty feet farther before encountering any ore. Eighty-four feet from the mouth of No. 2 tunnel a winze was sunk in ore down seventy-two feet; here they stoped out seventy-seven feet in length and thirty-five feet high. Four hundred and fourteen feet from mouth of No. 3 tunnel is an air shaft connecting with No. 2. Both walls are of the same formation—porphyritic slate. The ore contains tellurium, sulphurets, and free gold. The ore is reduced with a Dodge pulverizer and concentrated on Triumph concentrators; free gold is caught on silvered plates. Only the refuse ore is worked in this way. All the selected ore is shipped to the Selby Smelting Works. Of this kind of ore three carloads a month are shipped, and returns show that it runs from $240 to $290 in gold per ton, and $10 in silver. The owners, Messrs. Hart & Flemming, formerly had a five-stamp mill on the property. They took out the stamps and substituted the Dodge pulverizer. With the stamp mill they saved only 53 per cent, while with the pulverizer they are saving 93 per cent. They claim the stamps made too much slimes, which carried off the fine gold. Nos. 1 and 2 tunnels are in ore of the same character as No. 3.

Altitude	1,620.
Dimensions of claims	1,500 by 600 feet.
Nearest town	Redding.
Nearest distance to railroad	1½ miles.
Cost of freight from railroad to mine	$2 per ton.
Cost of freight from San Francisco to nearest railroad	$13 50 per ton.
Average width of vein	8 feet.
Length of tunnels timbered	1,200 feet.
Dimension of tunnels	4½ by 6½ feet.
Formation passed through	Ledge matter.
Number of feet run per shift	2.
Length of ore shoot	400 feet.
Number of shoots being worked	2.
Pitch of ore shoot	Northeast.
Number of air shafts	2.
Depth of air shafts	135 and 80 feet.
Timber used	Pine.
Cost of timber used	4 cents per foot.
Kind of powder used	Safety Nitro.
Distance to timber	1 mile.
Distance to lumber	8 miles.

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CHROME IRON.

Simms Station is located fifty miles north of Redding on the Oregon and California Railroad, in Secs. 17 and 18, T. 37 N., R. 4 W. The altitude above sea level is one thousand seven hundred feet. The formation of the country is slate and granite. We also find considerable serpentine rock. The general trend is north and south. About five miles south of the station we come to a creek known as Bowlder Creek. Near this locality superior deposits of chrome iron are found, and have been traced from Bowlder Creek to Little Castle Creek, a distance of fifteen miles. Two miles south of Simms one of these deposits has been opened and worked. It is located on what is known as Shotgun Creek. This deposit produced last year two thousand tons of iron, which was shipped to Baltimore, Maryland. The owners of the mine realized a royalty of $3 per ton on each and every ton shipped. The parties who contracted with them paid all expenses, mining, shipping, etc.

Southeast of Simms is Hazel Creek; it is from twelve to fifteen miles in length, and empties into the Sacramento about one mile south of the station. This creek was very rich in gold, and was worked nearly all the way from its source to where it empties into the Sacramento River. The formation of the country is slate and granite. The country is well timbered with spruce, pine, and cedar. There is water in abundance, both for mining and agricultural pursuits.

COPPER CITY SILVER MINES.

These mines are situated on the west side of Squaw Creek, a tributary of Pitt River, in T. 34 N., R. 3 W., M. D. M., and about twenty miles northeast of the town of Redding. The trend of the vein is northeast and southwest, and dips to the west about 30 degrees. These properties were first discovered in 1862 by Charles Williams, who worked the croppings in a hand mortar, and made fair wages, as a bunch of the croppings was rich in gold. This caused an excitement, and made the district prominent. In 1863 the leading mine was incorporated under the name of the Williams and Kelliner, afterwards known as the Winthrop, and was patented by Spruance, Stanley & Co., of San Francisco, as the Excelsior. There has been a large expenditure of labor and money on this mine; one tunnel was driven over one thousand two hundred feet, and it is now believed that the face of this tunnel is in the east wall rock of the vein, as subsequent developments show that the vein is farther west. Several plants have been erected near this mine at great cost, as it contains a vast body of fair grade ore, but owing to the fact that the ore carries copper, zinc, antimony, and other base materials, no successful mode has yet been applied to make the working of the ore profitable, although much of the ore assays high, and by a proper concentrating process these mines may become very valuable. The vein has been traced from Pitt River to Bully Hill, a distance of seven miles, the latter place being about four miles northeast of Copper City. A tramway was built from the Bully Hill Mine to the Copper City plant, and a large amount of surface ore worked, but as depth is attained, the ore carries more base metals. The mines of note in this district are the Winthrop or Excelsior, the Baxter, Chance, Bully Hill, and Northern Light. The formation is slate on the east and granite on the west; a heavy clay gouge accompanies the vein on the west wall.

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SQUAW CREEK MINES—BACKBONE MINING DISTRICT.

Uncle Sam Mine.

The Uncle Sam is the most promising mine in the district. It is located in T. 33 N., R. 6 W., M. D. M. The elevation above sea level is two thousand and forty feet. This property was located in 1886. The district is known as the Backbone Mining District. The claim is one thousand five hundred feet by six hundred feet. The nearest town is Kennett, on the Oregon and California Railroad. The direction and distance from town is seven miles northwest. Cost of freight to railroad station is $17 per ton, and $10 per ton from railroad to mine. The vein courses northwest and southeast, and dips northeast with a variation of 50 to 75 degrees. The average width of vein is four and one half feet. The formation of both hanging and foot walls is porphyry. The property is opened by tunnels, four in number, and are designated as follows:

No. 1, south vein	116 feet.
No. 2, south vein	750 feet.
No. 3 south vein	800 feet.
Gillispie tunnel	230 feet.

The vertical depth reached from surface is four hundred and sixty feet. The average cost of running tunnels has been about $5 per foot. The ore shoot as far as known is two hundred feet. Four shoots are being worked; two hundred feet is the greatest length of ground stoped. The pitch of ore shoot is almost vertical. Two air shafts have been sunk for ventilation: one, one hundred feet; another, sixty feet.

Ore is transported to works by means of a tramway at a cost of 15 cents per ton. Lumber is hauled from Kennett, a distance of seven miles, and costs $25 per thousand. The company have built five miles of road at a cost of $9,000. They have also built a ditch three thousand three hundred feet in length. The ore is reduced by means of a twenty-stamp mill, and concentrated on four Frue and four Triumph concentrators. The percentage of sulphurets is 1¾, valued at $100 per ton; they are composed of sulphides of iron and copper. The motor used is water. Height of fall is one hundred and twenty-six feet. The company propose to put in engine and boilers to use when the water is low.

Elevation	2,040 feet.
Length of ore shoot	200 feet.
Kind of timber used	Pine.
Kind of powder used	Gelatine, dynamite.
Quantity of powder used	1,500 pounds per month.
Distance to lumber	1 to 3 miles.
Cost of lumber	15 cents per foot.
Length of road built	5 miles.
Cost of road built	$9,000.
Length of ditch built	3,300 feet.
Cost of ditch	Not stated.
Character of ore	Iron and copper sulphurets.
Screens	No. 40 wire.
Plates, size of apron	4 by 6 feet.
Width in sluice	16 inches.
Length in sluice	16 feet.
Size inside battery	4 feet.
Plates on battery	Silvered.
Kind of feeder used	Challenge.
Kind of metal for shoes and dies	Steel.
Kind of compressor used	National.
Name of drill used	Phœnix.
Number of stamps	20.
Weight of stamps	900 pounds.

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SIERRA COUNTY.

By L. P. GOLDSTONE, E.M., Assistant in the Field.

This county was one of the first heavy gold-producing counties of the State. Its surface is very mountainous, having some of the highest mountains and ridges of the Sierra Range within its limits. The ridges are cut by deep cañons, whose sides are generally very precipitous. The county is one of the best watered of the counties of the State, containing within its confines the North Fork of the Yuba River, with its lesser forks and tributaries, the Feather River, and the Truckee River, the latter rising in the southeastern portion of the county in Webber Lake. There are numerous lakes in the county. In the northern portion there are Bear, Spencer, Gold, Gray, Packer, Volcano, Young America, Upper Salmon and Lower Salmon, Upper Sardine and Lower Sardine Lakes; and in the southeastern portion, there are Webber, English, Eureka, and Meadow Lakes.

The county contains numerous belts of fine timber of yellow pine, fir, cedar, sugar pine, etc., and in all sections there is a sufficiency of timber and wood for mining purposes. In the western portion of the county, several large gravel channels cross north and south through the county which have produced great quantities of gold. They have been worked extensively by hydraulic process until the law enforcing its suppression was established. After that time drift mining was necessarily more extensively carried on, and with marked success, as for example, at the Bald Mountain Claim and its extensions, the South Fork Mine, and numerous other places in the county.

In the same section—the western portion—of the county, much volcanic detritus and basaltic capping overlies the channels, slates, and greenstone; whose general trend is northwest and southeast, varying in dip from 60 to 45 degrees.

My time being limited, I was unable to visit each of the points of importance as to mining, hence I selected the principal mining district of the county, which is in the neighborhood of Sierra City, for my limited examination. The other sections of the county will hereafter receive the full attention which they deserve.

In the immediate vicinity of Sierra City, in T. 20 N., R. 12 E., in which that city is situated, there are some of the principal mines of the county and, in fact, of the State. Veins of quartz and channels of auriferous gravel course through it at all angles. I have compiled a map of this township to show the relative positions of the various ledges, the locations upon them, and their conflicts with one another; and also the positions of the various lakes in the section, which are the source of water power for many of the principal mines; and the altitudes, which latter will give some idea of the great heights and the deep erosions which have taken place. The map is herewith appended. It shows the Sierra Buttes group of mines, which have paid dividends from the first days of their discovery to the present time, and have produced, it is said,

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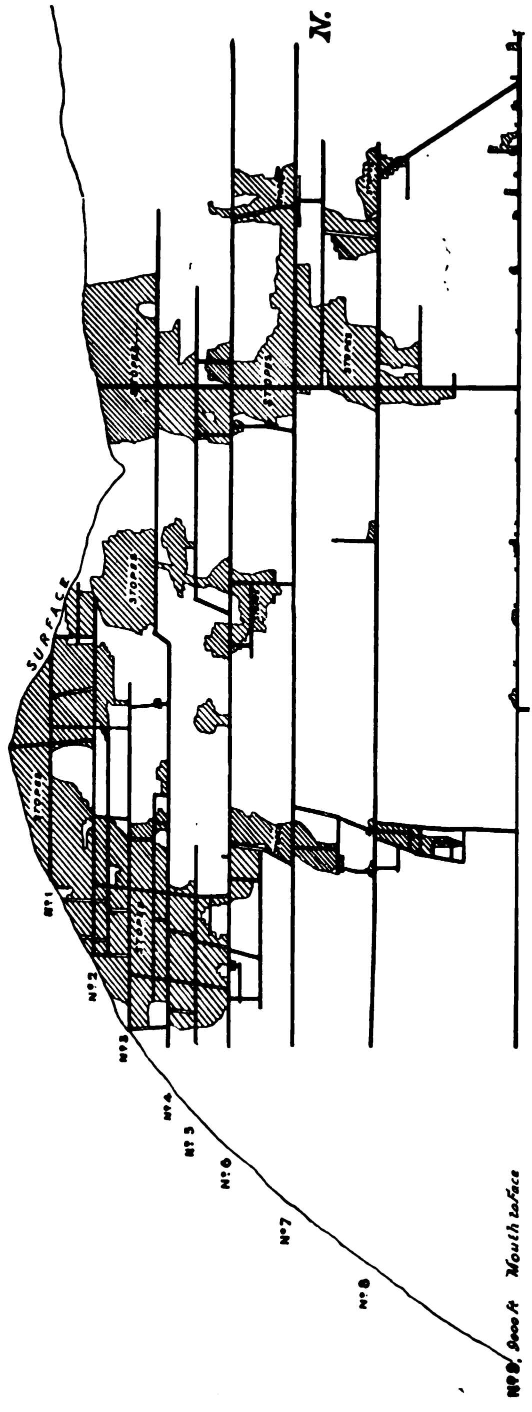

LONG. CROSS SEC. SIERRA BUTTES MINE
Scale 400 to One Inch.

is a crosscut tunnel until the vein is reached, when it continues on it west two thousand two hundred feet in length. It is three hundred and six feet below No. 1. No. 3 tunnel is also a crosscut tunnel, and after cutting the vein it runs on the vein one thousand seven hundred feet, and is five hundred and seventy-five feet below No. 2. No. 4 tunnel is a crosscut also, and at present one thousand nine hundred and fifty feet long. It is estimated by survey that it will have to be continued to a length of two thousand five hundred feet before the vein will be reached in No. 4; and by this tunnel a depth of one thousand five hundred feet will be attained. From the surface a shaft was sunk near the apex of the mountain, one hundred and thirty feet in depth, striking No. 1 tunnel three hundred and seventy feet from its mouth.

From the different tunnel levels upraises have been made to this shaft, which now, with the winze sunk below No. 3 level, gives a continuous shaft one thousand two hundred and ninety feet in length. Between the different tunnels intermediate drifts have been run on the vein, both east and west from the shaft. From the surface to No. 1 tunnel there are two intermediate drifts, one at a depth of ninety feet below the surface, running east fifty feet and west one hundred and twenty feet; and ninety feet below the latter, another, running east one hundred feet and west one hundred and fifty feet. Between Nos. 1 and 2 tunnels, equidistant, a drift has been run east one hundred and twenty-five feet and west five hundred feet. Between Nos. 2 and 3 tunnels two intermediate drifts have been run, the uppermost being one hundred and eighty-seven feet below No. 2 tunnel, and being four hundred feet in length east of the shaft and six hundred and seventy feet west. One hundred and ninety feet below the last named drift another intermediate drift is run four hundred feet east of the shaft and six hundred and fifty feet west. A series of upraises have been made at different points through the mine, connecting the different tunnels and intermediate drifts, which gives a most perfect system of ventilation. The greatest amount of ore has been extracted from the first intermediate drift above No. 3 tunnel to the drift, which is equidistant from Nos. 1 and 2 tunnels, giving a distance of five hundred feet on the vein in height by six hundred feet in length. This has been entirely stoped, and has produced the larger portion of the bullion thus far taken from the property. Above No. 1 tunnel to the surface stopes of various lengths have been driven; and from No. 3 tunnel, on the eastern side of the shaft, a stope, averaging about one hundred feet in length, has been carried to the level above. The ore shoot pitches slightly to the west. Fourteen dollars has been the average cost of crosscutting per foot to the vein.

Both Nos. 1 and 2 tunnels have been timbered through their entire length, while No. 3 tunnel is timbered only through one half of its length. Round pine and fir timber was used, costing 8 cents per linear foot. The hanging wall is porphyry, intermixed with talcose slate, and the foot wall is slate and diorite. Hercules powder Nos. 1 and 2 is used as an explosive in the mine. Two tons of steel are used each year in the mine and works. The ore costs $3 per ton to mine, and lumber is delivered at the works for $20 per thousand feet. The company has built ten miles of road at a cost of $10,000, and three miles of flume at a cost of $12,000. Ore is transported from No. 3 tunnel to the mill by a gravitation tramway, at a cost of 20 cents per ton, and is dropped to

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No. 3 tunnel from the upper levels by a series of shoots. The character of the ore is quartz, containing one half of 1 per cent of sulphurets of iron and copper, and is reduced in a wet-crushing mill of forty stamps. Each stamp weighs seven hundred and fifty pounds, and is dropped seven inches eighty-four times per minute. The height of the discharge above the dies is six inches, and the duty per stamp each twenty-four hours is one and one half tons.

Both Nos. 7 and 8 slot-punched screens are used, and the size of the screens inside of their frames is forty-four inches in length by six inches in width; they are slightly inclined. The aprons to each battery are forty-eight inches in width by fifteen inches in length, emptying into sluices fifteen inches wide by sixteen feet long. All are covered with silver-plated copper plate. The Challenge ore feeder is used in the mill, and four Triumph concentrators; but latterly the concentrators have not been in use, as the percentage of sulphurets is very small, and they do not average over $50 per ton in gold. Of the gold recovered, 80 per cent is found in the battery, and 20 per cent on the outside plates. Seventy-two men are employed in the mine, six in the mill, and forty-two outside, making a total of one hundred and twenty men in the employ of the company. The average wages for miners is $2 50 per day; in the mill the average wages are $3 per day; and outside work, which includes timbermen, teamsters, breakmen, blacksmiths, etc., average $2 25 per day. The mill is supplied with power by a six-foot Pelton waterwheel, under two hundred and thirty feet of pressure. A three-foot wheel, under the same head, is used to run the air compressor, which furnishes power for a Burleigh drill in No. 4 tunnel. This mine has produced, in bullion, to the time of my visit, $1,350,000.

Altitude	7,200 feet.
Altitude of lower tunnel	6,200 feet.
Length of No. 1 tunnel	1,370 feet.
Length of No. 2 tunnel	2,400 feet.
Length of No. 3 tunnel	2,315 feet.
Length of No. 4 tunnel	1,950 feet.
Kind of powder used	Hercules Nos. 1 and 2.
Cost of running No. 4 tunnel	$14 per foot.
Dimensions of No. 4 tunnel	7½ feet high by 9 feet.
Length of tunnels timbered	5,000 feet.
Kind of timber	Round pine and fir.
Cost of timber	8 cents per foot.
Distance of mine from lumber	4 miles.
Cost of lumber	$20 per thousand.
Length of road built by company	10 miles.
Cost of road	$10,000.
Length of ditch (flume)	3 miles.
Cost of flume	$12,000.
Character of ore	Quartz, with sulphurets of iron and copper.
Character of works	Wet-crushing mill.
Number of stamps	40.
Weight of stamp	750 pounds.
Height of drop	7 inches.
Drops per minute	84.
Height of discharge	6 inches.
Duty per stamp in twenty-four hours	1½ tons.
Kind of shoes	Chrome steel.
Kind of dies	White iron.
Cost of shoes	10 cents per pound.
Cost of dies	6 cents per pound.
Size and character of screens	Slot-punched, Nos. 7 and 8.
Kind of feeders	Challenge.
Percentage of gold recovered saved in battery	80 per cent.
Percentage of gold recovered saved on plates	20 per cent.
Kind of concentrators	Triumph.
Number of concentrators	4.

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stamps, and they will be dropped ninety times per minute. Chilled iron shoes and dies are to be used, at a cost of 6½ cents per pound. No. 7 slot-punched screens will be used, with a surface of forty-eight inches in length by six inches in width inside of the frames. The apron plates will be forty-eight inches in width and thirty-six inches in length, with twelve feet of sluice to each battery, eighteen inches wide. Challenge ore feeders will be used. The number of men in the mine, estimated by Mr. Harper, the Superintendent, will be fifty. Their wages will be $2 50 per day. There will be eight men in the mill, with wages averaging $3 per day, and four men outside, whose wages will average $2 per day. A five-foot Pelton wheel is in place to run the mill, and the head at this point will be two hundred and thirty-five feet.

THE COLOMBO MINE.

This mine is situated three and one half miles southwest of Sierra City, and its works are at an altitude of five thousand one hundred and fifty feet above sea level. It was located in 1875. The vein courses northeast and southwest, and dips to the north at an angle of 45 degrees, and averages three and one half feet in width. The mine has been opened by two crosscut tunnels and a shaft. No. 1 tunnel is driven into the hill one thousand seven hundred feet, when it encounters the vein, striking it where a shaft has been sunk from the surface one hundred and fifty feet in depth, and at this level drifts have been run on the vein from both sides of the shaft, running east three hundred feet and west four hundred feet. The lower crosscut strikes the vein in its course one thousand five hundred feet, and one hundred and sixty feet below where No. 1 intersects it. A drift has been run on the vein west from the shaft one hundred and thirty feet. The tunnels have averaged in cost $7 per foot, and have been timbered half their length by round pine timber, costing 9 cents per foot. The vertical depth reached is four hundred feet. The formation of the hanging wall is slate, and of the foot wall porphyry. Stopes have been run four hundred feet continuously, and the ore has averaged $7 per ton. From the first level to the surface nearly all the ore has been stoped. Hercules powder is the explosive used in the mine, and its average consumption is about two pounds to the ton of ore extracted. The cost of mining averages $2 per ton of ore.

The company has built one mile of road at a cost of $2,000. The means of transporting the ore from the mine to the mill is by a gravitation tramway, and costs 6 cents per ton. The means of reducing the ore is by means of a ten-stamp mill of eight hundred and fifty-pound stamps, which are dropped six inches eighty times per minute. The height of the discharge is eight inches, and one and one half tons of ore is the duty per stamp each twenty-four hours. No. 9 slot-punched screens are used in the mill, and chilled iron shoes and dies. Shoes and dies cost 6½ cents per pound. The apron plates are forty-two inches in length by eighteen inches in width, and the sluices are eighteen inches wide by ten feet long. Silver-plated copper plates cover the aprons and sluices. They have an inclination of one and one half inches per foot. Challenge feeders are used in the mill. Sixty-five per cent of the gold recovered is saved in the battery, and 35 per cent on the outside plates. The ore contains a very light percentage of sulphurets. Eight men are employed in the mine at wages averaging $1 92 per day and board, and

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per cent of sulphurets are contained in the ore, which, by assays, average $280 per ton in gold.

A ten-stamp mill is on the property, each stamp weighing eight hundred and fifty pounds, which are given six inches drop, and are dropped eighty times per minute. The height of the discharge above the dies, when they are new, is five inches. The screens are iron wire No. 50, and their surface inside of the frames is forty-four inches in length by ten inches in width. The aprons are four feet wide by five feet in length, and a sluice fourteen feet long by twelve inches in width is at each battery. Both aprons and sluices are covered with silver-plated copper. A front inside plate is also used, eight inches in width by forty-four inches long. The mill is fed by hand. Seventy-five per cent of the gold recovered is saved in the battery, and 25 per cent on the outside plates. The ore is concentrated by two Frue concentrators. None of the concentrators have yet been worked. Eight men are employed in the mine, two in the mill and three outside. Wages in the mine average $2 50; in the mill, $3 50 per day, and outside, $2 per day. The mill is run by water power, which is free.

Altitude	5,500 feet.
Length of ore tunnel No. 1	700 feet.
Length of ore tunnel No. 2	600 feet.
Length of tunnels timbered	600 feet.
Kind of timber	Round fir.
Cost of timber	2½ cents per foot.
Character of ore	Ribbon quartz, with iron pyrites.
Cost of mining per ton	$2.
Kind of powder used	Giant No. 2.
Distance of mine from lumber	27 miles.
Character of works	10-stamp wet-crushing mill.
Weight of stamp	850 pounds.
Drop of stamps	6 inches.
Drops per minute	80.
Height of discharge	5 inches.
Kind of shoes and dies	White iron.
Cost of shoes and dies	6 cents per pound.
Size and character of screens	Iron wire No. 50.
Size of aprons	4 by 5 feet.
Width of sluices	12 inches.
Length of sluices	14 feet.
Kind of feeder	Hand.
Kind of concentrator	Frue.
Number of concentrators	2.
Percentage of sulphurets	2 per cent.
Value of sulphurets	$280 per ton.
Number of men in mine	8.
Number of men in mill	2.
Number of men outside	3.
Average wages in mine	$2 50 per day.
Average wages in mill	$3 50 per day.
Average wages outside	$2 per day.
Kind of power used	Water.
Cost of power	Free.

THE CLEVELAND MINE.

This mine is situated five miles southwest of Sierra City by road. It was located in 1886, and the dimensions of the claim, with its extensions, which belong to the same company, are four thousand five hundred feet on the vein by six hundred feet wide. The works are at an elevation of four thousand five hundred and fifty feet above sea level. The trend of the vein is north 25 degrees west, and dips to the east at an angle of 78 degrees, and averages in width one foot.

The vein has been opened by a series of three tunnels. No. 1 tunnel

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one hundred feet above sea level, and the dimensions of the claim are three thousand five hundred feet in length by six hundred feet in width. The works are five miles southwest by trail from Sierra City. The vein courses northeast and southwest, dipping to the north 80 degrees, and averages six feet in width. The formation is slate, through which the vein courses. The mine is opened by a series of tunnels: No. 1 being seven hundred feet long, No. 2 nine hundred feet, No. 3 six hundred and fifty feet, and No. 4 one thousand one hundred and forty feet in length. The lower tunnel is one thousand and thirty feet below the top of the ridge across which the vein courses. The ore shoot is seven hundred feet long, and continuous stopes have been run that distance. Round pine and fir timber are used on the mine, there being an abundance on the property. The cost of mining averages $2 per ton. Lumber is delivered at the mine for $26 per thousand feet. One and one half miles of road have been built by the company at a cost of $800. The ore is transported to the works, one thousand six hundred feet, by a small car, at a cost of 15 cents per ton. A twenty-stamp mill is on the property, of seven hundred and fifty-pound stamps. At present there is some prospecting being done in the lower levels, preparatory to extensive operations being undertaken by a new company. This mine has the reputation of having produced very largely, and its ore having been of high grade.

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Salmon River, a succession of benches and terraces, through which the river has cut its way, yielding to the miner their auriferous contents.

The mines were quite fully described in the report of 1888, since which time the mining outlook has continued to improve; the mines, then producing, still continuing to yield handsomely, and many new discoveries having been added.

One of the most important of these is the discovery of an extensive river channel near Henley, on Cottonwood Creek, showing the character of the famous blue gravel lead, of which it is supposed to be a continuation. The auriferous black slate belt, commonly known as the Mother Lode, traverses the county from north to south, forming even in places the apex of mountain ranges, and covering a large area of the region west of the line of the California and Oregon Railroad.

Near the county seat, at Yreka, the mines in the Humbug Creek section are showing continued developments, and if those lately discovered should be systematically and regularly worked, the owners will receive remunerative returns for their enterprise.

The mines and prospects near the summit of the Humbug Range have produced considerable gold.

The Shroeder and Werner ledges, in Deadwood District, have a large force of men at work keeping the steam mill running constantly, with successful results.

At Forks of Humbug Creek over fifty tons of ore were crushed lately at the McCook Mill, which paid from $50 to $80 per ton. The ledge is three to four feet wide. The returns from the mill proving so sanguine, it is the purpose to erect a larger mill this fall.

Boyle & Co.'s Mine, at the head of Humbug, has furnished ample ore to keep their mill running steadily.

The McConnel Claim, below the mouth of Humbug, is paying well. The Centennial Claim, below Honolulu, is also paying well.

The principal quartz mine of the Salmon River Range is

THE BLACK BEAR MINE.

This property is located about seven miles from Sawyer's Bar, near the head of Black Bear Gulch, on Sec. 13, T. 40 N., R. 12 W. The altitude at entrance to main tunnel is three thousand five hundred feet.

The property includes the Black Bear and Yellow Jacket locations, covering six hundred by four thousand five hundred feet of the lode. The mine was successfully and profitably worked for years by the Black Bear Mining Company, and yielded about $6,000,000. After working out, as they supposed, the Black Bear ore bodies the mine was shut down, and remained idle for several years. It was, however, purchased for a nominal sum by ex-Lieutenant-Governor Daggett, who was the original locator and owner of the property. After clearing out and retimbering the main shaft and level the first crosscut was driven by Mr. Daggett, and it struck the continuation of Yellow Jacket shoot or ore body from the crosscut. Levels are driven and stopes opened which are yielding good milling ore.

Mr. Daggett intends pumping out the incline shaft below the tunnel level, for the purpose of driving crosscuts from the lower levels, and feels confident that he will succeed in finding the continuation of the

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Black Bear ore body, which was in places one hundred and ten feet wide and yielded $14 ore.

The mill of sixteen stamps is located down in the cañon about one and one fourth miles below the mine. The ore is transported to the mill by means of a tramway.

The mill is run by a Pelton wheel sixteen feet in diameter, driven by water delivered under a head of two hundred and sixty feet.

There is a small iron foundry in connection with the property, in which are cast all shoes, dies, car wheels, and castings required in the mine or mill. There is also a sawmill for cutting timbers and lumber for the mine.

Altitude	3,500 feet.
Length of tunnel	2,600 feet.
Depth of workings on incline	1,000 feet.
Number of ore shoots	2.
Length of Black Bear	400 feet.
Length of Yellow Jacket	400 feet.
Width of vein varies from	1 to 100 feet.
Character of foot wall	Black slate.
Character of hanging wall	Black slate.
Dip of vein	25 to 50 degrees east.
Water used for power	100 miner's inches.
Cost of water	Nothing.
Number of stamps	16.
Weight of stamps	750 pounds.
Drop of stamps	8 inches.
Number of drops	90 per minute.
Height of discharge	3 inches.
Duty of stamps in twenty-four hours	24 tons.
Kind of shoes and dies	White iron.
Dimensions of aprons	42 by 72 inches.
Incline of plates per foot	1 inch.
Size of inside plates	5 by 42 inches.
Kind of screens	Slot-punched, No. 7.
Kind of feeders	Hand.
Sulphurets	2 per cent.
Value of sulphurets	$80 per ton.
Number of men employed in mine	20.
Number of men employed in mill	2.
Number of men employed on outside work	3.

The Gold Ball Mining Company, at Salmon River, has been taking out rich quartz from the Mountain Laurel. Rich deposits of gold were found in the casing of the hanging wall. The company has expended considerable money in developing their ground. The ledge, being four to five feet wide, has already produced a large quantity of quartz, which will average about $20 per ton.

The Gold Run Mine, at Know Nothing Creek, is one of the best paying mines in the county. On first tapping the ledge in the tunnel, twenty-three tons of quartz were extracted, which yielded $6,000, and a further three hundred tons realized over $29,000. It is the intention of the company to obtain additional machinery, in connection with the newly completed ditch.

The Hansen Mine has resumed work after a suspension of over six months. On Greenhorn Creek an open cut is being sunk to bedrock, a distance calculated to be eighty feet; the cut is being kept drained by a large steam pump. These diggings have never been opened before on account of the amount of water there was to handle.

An English company, owning a ledge on Methodist Creek, a tributary of the Salmon, are about to thoroughly prospect their ground.

For many years past rich pieces of "gold float" have been picked up

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SOLANO COUNTY.

By W. L. WATTS, Assistant in the Field.

The mineral resources that have hitherto been developed in Solano County are the quicksilver mines near Vallejo, the manufacture of basalt blocks, the Tolenas Springs and marble quarries, and industries connected with clay and limestone.

During the last year especial attention has been given to the inflammable gas, which has been discovered in the tide-water lands bordering the Sacramento River.

Its occurrence at this point shows that the gas, which has been found beneath the alluvial strata at Stockton and other places higher up the river, extends down the valley of the Sacramento. For natural gas to be obtained at points commanding river navigation, is particularly advantageous, and should the supply prove constant, it is no doubt only a matter of time for it to be utilized in connection with manufactures, especially those that are objectionable in crowded cities.

The interests of Solano are principally centered in fruit and cereal crops.

The county is traversed by no large streams, except upon the eastern and southern boundaries, but the climate is sufficiently humid for vegetation to thrive without the aid of irrigation. As will be seen by a perusal of the following pages, a good supply of subterranean water can be obtained in most places at an inconsiderable depth.

THE THOMAS BASALT QUARRIES.

These quarries are situated one mile east from Cordelia, in an isolated mound of basaltic lava, which appears to be a continuation of the basaltic formation that extends northward, overlying the shales and sandstones of the Coast Range, along the western boundary of Solano County.

For the last fifteen years, basaltic blocks have been quarried from this hill, and about seven years ago, extensive quarries were opened on the property, which covers about two hundred acres. Since then the work of block-making has been actively carried on, and at times as many as sixty men have been employed. The blocks manufactured there have been principally used in San Francisco; recently, some have been shipped to Stockton and San José. The basalt varies in color from a dark blue to gray; it also varies in texture, most of the stone being of good quality, and the cleavage regular except at right angles to the plane of bedding. In another portion of the quarry, the stone, though apparently solid, breaks with comminuting and irregular fracture. In places where crevices extend throughout the breadth of the workings, decomposed clayey matter is found therein, frequently inclosing fragments of volcanic rock. Occasionally the compact basalt shows lines parallel to the plane of its bed. Along these lines the stone is somewhat vesicular,

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COAL.

Several years ago much prospecting work was done for coal on the northeast side of Vaca Valley; several tunnels were run and shafts sunk, but the veins of coal discovered were only a few inches in thickness.

Coal also crops out upon the Marshall Ranch, on Suisun Creek, and a small vein of coal is said to have been discovered there. As already reported, the coal measures also make their appearance in the American Cañon in the southwest portion of the county and at several other points.

QUICKSILVER.

From 1867 to 1869, work was carried on at the St. John's Mine, a few miles north of Vallejo. Three furnaces were erected, and several thousand flasks of quicksilver were reduced. It is stated work has been resumed on the mine.

WATER—SHALLOW WELLS.

Around Dixon, a good supply of water is usually obtained at a depth of forty-five to sixty-five feet. The formation observed in boring has been as follows:

Character of Strata.	Thickness of Strata, in feet.
Soil, adobe and clayey loam	3 to 4
Sandy clay	18
Sand and fine gravel, with hard water	3
Yellow clay, tough	40 to 60
Sand and gravel, with water	2 to 5
Tough yellow clay	25
Sand and fine gravel, with water	3 to 7

In a well bored to supply the town of Dixon, the clayey strata was somewhat thicker, but a good supply of water was obtained at a depth of ninety-five feet. The boring was continued to a depth of four hundred and ten feet through a grayish clay, which, at times, became very sandy. Charred wood and charcoal have been found in the vicinity at a depth of one hundred and seventeen feet.

To the north of Dixon, the water-bearing strata are very similar to those above mentioned, but as Putah Creek is approached, large beds of gravel and cobblestones are encountered.

Along the foothills to the west of Dixon, the water-bearing strata are deeper and more uncertain. This is true of the country lying northeast from Vacaville towards Putah Creek. In that direction, a rolling country extends along the foothills, forming the first bench, from which the Coast Range rises towards the west. Throughout this district the soil is gravelly, except where the creeks have, in some cases, brought down an excess of sandy or clayey material.

In many wells which have been bored in this district a gravelly soil has been penetrated for three or four feet, beneath which a stratum of hardpan has been passed through for about forty-five feet; beneath the hardpan a quicksand and gravel have been reached, which contains a fair supply of water.

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In Elmira and vicinity, wells are generally bored to a depth of from thirty to sixty feet. The formation penetrated is as follows:

Character of Strata.	Thickness of Strata, in feet.
Surface soil, sandy loam	6 to 10
Dark-colored sand, containing very hard water	3 to 4
Yellow clay	10
Sand, sometimes passing into gravel	14

From this sand or gravel the water rises to within ten feet of the surface of the ground. The water supply in the second stratum of sand is practically inexhaustible. Logs of wood have sometimes been bored through in this vicinity at a depth of twenty-five feet.

Northward, toward Dixon, a similar formation has been observed, but the water is said to be a little deeper. Eastward from Elmira, toward the Sacramento River, through the district lying immediately to the north of Ulattis Creek and Cache Slough, the wells are much shallower, a good supply of water being frequently obtained at a depth of fifteen feet; few wells in that neighborhood exceeding the depth of thirty feet. As the Sacramento River is approached in the eastern extremity of the county, a supply of water can be obtained at a depth of from twelve to twenty-five feet, but the water is very hard and at times unfit for use. Along the river, between Rio Vista and the Sacramento County line, the marginal lands, observed higher up the river, appear to taper down to a few feet of bank. In wells bored in the "tule" lands near the river, the following formation has been observed:

Character of Strata.	Thickness of Strata, in feet.
Peaty bog, containing "alkali" water	35 to 40
Soft blue clay	6 to 8
Quicksand, which is usually penetrated	20 to 30

A false bottom is put in the wells of this district, by filling the lower part of the boring and the first few feet of the casing with gravel; by this means the quicksand is shut off and a good supply of water obtained. It appears from the testimony of well borers, that between Maine Prairie and the Montezuma Hills the water-bearing strata lie at a greater depth.

Thus, on the Thomas Ranch, in boring for water a reddish clay loam passing into soft reddish clay was penetrated for over forty feet, before the stratum of sand was reached containing enough water to supply a windmill pump.

As the Montezuma Hills are approached the wells are usually from eighty to two hundred feet deep.

Thus, upon the Cameron Ranch the following formation was observed:

Character of Strata.	Thickness of Strata, in feet.
Gravelly soil	1
Chalky hardpan	7
Yellow clay	40
Grayish clay	82

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At this depth a sand was struck containing a small amount of water.

In the vicinity of the Montezuma Hills, both animal and vegetable remains are, by no means, of infrequent occurrence in the superficial strata. Thus, about eight miles northwest of Rio Vista, a bed of "clam shells" was observed at a depth of sixty feet.

About five miles northwest from that town a "sycamore log" was bored through, and "mammalian bones" were discovered at a depth of sixty feet. About three and one half miles north of Rio Vista, molar teeth of a mammoth are said to have been found in a stratum of gravel at a depth of ten feet beneath the surface, while about a quarter of a mile west of the same place, where a cutting was being made in the side of the county road, the tusk of a "mammoth" was uncovered in the surface soil.

In the Montezuma Hills, the Mount Diablo series of rocks appear to be represented, overlaid by irregular stratified drift and clay, chalky hardpan, and sandy strata. In the drift, formations of both sides of the Sacramento Valley are represented the crystalline rocks of the Sierra and the metamorphic sandstone and shales from the Coast Range, mixed with pebbles of lava that may have been erupted by Uncle Sam Mountain, in Lake County, or Mount Shasta, still farther to the north; the softer volcanic ejectamenta, together with unaltered sedimentary rocks, having been ground to sand clay, probably by a glacial action.

In some places the gravel crops out upon the surface of the ground; thus, north of Denverton there is a gravelly ridge about four miles long, running approximately northeast and southwest, and varying from half a mile to two miles wide. At the few points where the drift is exposed, its stratification and the rounded character of the pebbles denote its sub-aqueous deposition, and the rearrangement and distribution it has been subjected to by the action of the waves. The Montezuma Hills are watered by numerous springs, and in many places, comparatively shallow dug wells have struck veins of potable water. Most of the bored wells, however, from which enough water is obtained to supply a windmill pump, are from one hundred to two hundred feet deep.

The following formation has been observed in boring:

Character of Strata.	Thickness of Strata, in feet.
Surface soil, generally adobe in the hills and frequently sand in the hollows	1 to 5
Chalky hardpan	4 to 6
Tough yellow clay	30 to 50
Blue plastic clay	40 to 50
Fine bluish sand	75 to 100

This sand yields a good supply of water.

The bluish sand passes into cemented sand and sometimes into pebbles. There is frequently a seepage of water at a depth of eighteen or twenty feet, but the amount is very uncertain.

The water between the Montezuma Hills and the Sacramento River is said to be frequently brackish or salt. Thus, on the Marshall Ranch, on rising ground about thirty feet above the "tule" lands, some four miles east from Collinsville, three wells were bored, all of which, it is said, yielded salt water. Also, upon Brown's Ranch, about four miles east of the Marshall property, wells were bored in yellow clay to a depth of from thirty-five to one hundred and forty feet with a similar result.

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Beneath the sandstone was a quicksand containing water.

The Potrero Hills, which at one time must have been a continuation of the Montezuma Hills, both being connected with the Coast Range upon the north, are principally watered by springs, although in depressions water can be found at a reasonable depth. The surface soil among the hills is for the most part sandy loam, while that of their outer slopes is mainly "adobe."

The Mount Diablo series of rocks crop out at several places, and the peculiarly rounded outline of the hills, like that of the Montezuma Range, is a characteristic feature of the landscape. Between the Potrero Hills and the Montezuma Slough, potable water is found in coarse gravel at a depth of from ten to fifteen feet, and the surface soil is "adobe." During the last two years, several wells have been bored on Grisley Island, some of them to a depth of about three hundred feet. Grisley Island, which comprises about a score of square miles of "tule land," is situated in an arm of the Suisun Bay, immediately to the south of the Potrero Hills. It is separated from the main land by the Montezuma and Nurse's Slough, and it is reached by a ferry established a short distance from Bird's Landing. In one well, which was bored to a depth of one hundred and ninety-six feet, at Dutton's Landing, on the southern shore of the island, the following formation was observed:

Character of Strata.	Thickness of Strata, in feet.
Rotten "tule" and bluish mud	40
Gravel and brownish sand, with "salt" water	45
Tough yellow clay	40
Blackish sand, alternating with strata of blue clay	103

The strata of sand were from ten to fifty feet in thickness, and the strata of clay from one to ten feet. The sand became cemented towards the bottom. All of the blackish sand contained water, but from some of the strata fine sand rose with the water. The well was cased for one hundred and ninety-six feet, the water used being obtained from the sand which was penetrated about nine inches below the casing. The water rose to within eighteen inches of the surface of the ground.

Another well was bored to a depth of three hundred feet in the northeastern portion of the island, and the following strata were penetrated:

Character of Strata.	Thickness of Strata, in feet.
Mud and "tule"	25
Yellow clay	72
Gravel containing salt water	3
Yellow clay, intercalated with strata of gravel, the clay strata averaging about twenty feet and the gravelly about five feet in thickness. The gravel yielded salt water, but some of the strata were nearly dry	195
Blue clay	5
Blackish sand	5

The last stratum yielded a good supply of water, which rose to within eighteen inches of the surface of the ground. This well is cased to the bottom of the blue clay at three hundred feet, and yields sufficient water to supply a windmill pump.

Several shallower wells were bored from one hundred and twenty to

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North from Fairfield, towards the Coast Range, a good supply of water is obtained at a depth of from fifty to seventy-five feet.

Throughout the Suisun Valley the water-bearing strata lie at a depth of about fifty feet. On the James Ranch a spring of water was struck at a depth of thirty feet, which yielded a flowing well. In the upper portion of the valley, and close to the hills, the wells are naturally deeper, except where veins of water are encountered.

THE TOLENAS SPRINGS.

These springs, which have been referred to in previous reports, are situated in a terminal ridge of the Coast Range, which descends somewhat precipitously to the Suisun Valley. The Tolenas Springs have been discovered about forty years, and of late their waters have been in great demand on account of their medicinal virtues. Some time ago, where the spring now used for supplying the market came out of the ground, an excavation was made to the depth of ten or twelve feet through several strata of calcareous tufa, which had been deposited by the waters of the spring. These strata were separated by layers of "adobe" clay; at ten feet a white sand was passed through which rested upon a level floor of whitish clay, through which a hole two inches in diameter allowed the water to escape.

TOLENAS MARBLE.

This marble, which is quarried at the Tolenas Springs, has been locally miscalled onyx, as mentioned in a former report. It is a carbonate of lime, having sufficient hardness to be classed as aragonite. Several openings from which this marble is quarried have been made on the property of the Tolenas Company. At the entrance of the principal opening, masses of irregularly stratified travertine, which are weathered to a dirty gray, rise to the height of about thirty feet, and beneath a stratum of pure wax-like aragonite is exposed. The formation is the work of springs, which were, no doubt, more active formerly than at the present time. Travertine is still being deposited by a spring at the summit of the calcareous accumulation, in which the principal quarry has been opened. The waters of this spring are strongly saline, and its flow is accompanied by a free ebullition of gas.

There are several of these springs within a few yards of each other, their waters varying from the nauseous saline to pure spring water; the waters of some of them, especially the more saline, being charged with gas. The deposits vary from a dull gray, spongy tufa to a translucent, wax-like travertine. The principal exposure of the latter occurs in the quarry now being worked; it is found in layers, varying from a few inches to a foot or more in thickness, which are covered by a few feet of surface soil and light-colored clay.

As the travertine is approached the clay is penetrated by numerous veins and tubes of carbonate of lime, which increase in size toward the bottom of the clay. Beneath the clay is a stratum of coarsely honeycombed travertine; it is, in fact, a series of vesicles, the walls of which are composed of carbonate of lime. The inner walls of the vesicles frequently exhibit ripple-marked surfaces, and, it is said, sometimes

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As a consequence, it has suffered very little from earthquakes. A good many blocks, indeed, have been cracked through here and there, but the stones have not been displaced, and the building has not been really damaged to any noticeable extent. A similar sandstone, which has been used to some extent for retaining walls about private residences and for tombstones in the cemetery, was quarried in the northern part of the town of Benicia.

A visit to the old and somewhat famous "Suisun Marble Quarries," mentioned on page 104 of the "Geology of California," Vol. I, showed that they are located in a hillside some three hundred and fifty to four hundred feet above the sea, and distant some four and one half miles in an air line in a direction north 20 degrees east magnetic from the town of Suisun. A good deal of work was once done here. But the quarry has long since been abandoned, and no work of any consequence has been done here for many years—the present owner thinks for nearly thirty years, *i. e.*, since 1860. The trouble was exactly what is stated in the report above referred to, viz.: that, though much of the stone is very beautiful, it was impossible to obtain it "in masses of any considerable size."

The deposit is in the nature of a "stock-werk," the immediately surrounding and inclosing country rock being a breccia containing fragments of sandstone and clay shale, with occasional bits of what looks like volcanic ash rock, all cemented together chiefly by lime, and then traversed in all directions by veinules and irregular bunches of the so called "marble," which is aragonite, and much of which has the peculiar color and luster of rosin. Some of this "marble" is very delicately banded; other samples are not, and some of it is more or less crystalline in texture.

In the hills not far from this quarry there are said to be a fine sulphur spring and a fine soda spring, together with a third spring, which is strongly impregnated with various mineral salts, and which, although cold, is kept furiously boiling by the large volumes of carbonic acid gas which it discharges. There are also said to be large quantities of limestone of various kinds at several localities about here, and many years ago some of it was burned; but I could learn nothing reliable about the quality of the lime.

The "Tolenas Springs," and the so called "California Onyx Quarries," are not more than two hundred yards apart, and are situated in the hills about seven miles by the road, and probably six in an air line, in a direction just about north from Suisun, and are about seven hundred feet above the sea. The water of the springs is supersaturated with carbonic acid gas, and contains some common salt, with smaller quantities of other substances. The escaping gas is collected in a large holder, and pumped into the water under pressure. Some of the water, before being charged with gas, is flavored with various extracts, such as ginger, sarsaparilla, etc., and when bottled is then sold under different names, such as "Ginger Ale," "Sarsaparilla and Iron," etc. The product is said to be about seventy-five dozen bottles daily.

The "onyx quarry" is an isolated deposit of aragonite formed by mineral springs. On the surface it covers an area of an acre or more of ground, being between two hundred and three hundred feet in diameter. It forms a rounded knoll, which rises a number of feet above the adjacent ground. A quarry has been opened in the northern side of it, and

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SONOMA COUNTY.

By W. A. Goodyear, Geologist, and Assistant in the Field.

Between Knight's Valley and the Geysers nothing was seen but metamorphic rocks; that is, sandstones, serpentine, etc. The quantities of the latter rock are large. A considerable body of it occurs on the southern slope of the Pine Mountain Ridge before reaching Pine Flat, and there are numerous masses of it between the latter point and the summit of the ridge. On the northern slope, going down toward the Geysers, there was less of it seen. The strike of the rocks on the southern slope of this ridge seems generally northwesterly and the dip northeasterly. But they seem to have been much disturbed, and the stratification is oftener obscure than otherwise.

From the Geyser Springs, we climbed the Geyser Peak. The road which crosses the mountains here from the Geysers to Healdsburg passes within a few hundred yards of the crest of the peak. We estimated the distance by the road from the Geyser Hotel to its summit to be about seven miles. It is an easy pleasure ride, and the view from here is the finest that can be obtained in the immediate vicinity of the Geysers; though, as before stated, it bears no comparison with that from Mount St. Helena. The sharp and narrow chaparral-covered ridge, running northeasterly from the peak, and connecting with the larger mass of the ridge that lies between it and Pluton Creek, is called the Hog's Back, and at one point on its crest I noticed the rocks striking north 65 degrees to 70 degrees west, and dipping 75 degrees to 80 degrees northeast. All the rocks in this region are metamorphic, and nothing volcanic was seen southwest of the Cobb Mountain and northwest of Knight's Valley. There is a large body of serpentine in the Hog's Back, and also other masses irregularly distributed in the ridge between it and Pluton Creek, and probably all through this section of the country. In the metamorphic sandstones, the bedding is generally either very heavy or else almost entirely obliterated, and their stratification usually difficult and frequently impossible to make out without more time than we could give them. There also occur occasionally large bodies of jaspery rocks, and these are frequently in the form of thin-bedded shales, whose strike and dip, however, vary largely, showing the rocks to have been much disturbed.

At the distance of about two miles to the west of Geyser Peak, however, there is in the lower hills a fine exposure of a large mass of apparently heavy-bedded sandstones, which seem to have been not so irregularly disturbed, and perhaps not so highly metamorphosed as most of the rocks in this region. A line running from the peak south 35 degrees west magnetic would nearly touch the southeast extremity, and a line north 80 degrees west would touch the northwest edge of this exposure. As nearly as could be judged from such a distance, these rocks strike about north 20 degrees east, and dip about 20 degrees north-

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west. The summit of Geyser Peak itself is metamorphic sandstone, hard and very tough.

A description is given of the Geyser Springs in Vol. I of the Geological Report, pages 93 to 95, and my own notes of this locality do not in reality contain much that is new. Nevertheless, they contain a few details not mentioned there, and I may as well, perhaps, give them in full, notwithstanding the repetition involved. The little branch cañon called the Geyser Cañon, in which are the hot springs, is also known as the Devil's Cañon. I measured the temperatures of several of the springs and obtained the following results:

Eye Spring, 94 degrees Fahrenheit.

Another spring, a little farther up the cañon, 206 degrees Fahrenheit.

The Devil's Ink Spring, 200 degrees Fahrenheit.

The Alum Spring, 125 degrees Fahrenheit.

Another ink spring, 208 degrees Fahrenheit.

The Witches' Cauldron, 210 degrees Fahrenheit.

The Steamblower, near the Witches' Cauldron, 209 degrees Fahrenheit.

The temperature of the Witches' Cauldron was obtained by tying a thermometer to a stick, so that it could be completely immersed in the water; then getting eyes (and nose) as near to the edge of the cauldron as the heat and suffocating vapor would permit, and measuring and reading the thermometer as quickly as possible on lifting it out of the water.

The whole sidehill where these springs occur is thoroughly decomposed, and the variety of chemical products must be large. The quantity of water which runs from the springs is very small, and indeed most, if not all, the springs are in reality nothing more than steam blowholes, some of which issue in the bottoms of little basins of water, which are of course kept boiling, the water being furnished chiefly by the condensation of the steam, which is also charged with sulphuretted hydrogen and sulphurous acid. The Witches' Cauldron is one of these. The quantity of water which it discharges is very small indeed, and it is simply a pot-hole of water, which is kept furiously boiling by a cluster of large steam jets in its bottom.

The Steamboat Geyser is perfectly similar, only it is probably a stronger jet, and is upon the hillside instead of at the bottom of the cañon, and so there is no chance for water to accumulate over it. The mouth of the Steamboat Geyser itself is inaccessible, owing to the soft and dangerous character of the decomposed and honey-combed rock which immediately surrounds it. At the time of our visit steam was escaping from it under pressure which, judging as well as I could from the character of the sound, I should think might amount perhaps to five or six pounds per square inch.

The volume of steam discharged was pretty large and in the cool air of the morning made quite a heavy cloud, which hung sluggishly over the hillside.

The quantity of the steam here must vary largely with the season of the year, for Professor Davidson recently remarked to me that he had seen this Steamboat Geyser when the jet of steam issuing from it would rise forty or fifty feet from the orifice before it would condense sufficiently to be fairly visible, and this is much in excess of anything we saw.

There are not only very acid salts in the incrustations here, but the

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quantity of free sulphuric acid seems to be large. Much of the water tastes as sour as pretty strong lemonade, while some of the incrustations are most intensely acid, almost burning the tongue that touches them. There is much of the inky deposit of sulphide of iron in many places, and beautiful bunches of sulphur crystals and acicular crystals of various salts. The rocks here strike northwest and dip, perhaps, 40 to 50 degrees northeast.

There is stated to have occurred a year or two ago, at the Witches' Cauldron, an explosion, which sounded like the report of heavy cannon, and blew out a ton or two of rock, some of the pieces of which still lie there.

After visiting the Geysers themselves, I traveled a mile and a half or more down Pluton Cañon to the vicinity of the Indian Spring, and found a belt of this same solfataric action, extending all the way down along the north side of the cañon. It extends at least two miles below the Geysers, the same decomposition of the rocks showing how extensive the action has been. Nor is the action yet by any means extinct, so far as I went; but all along there can be seen here and there, at intervals, a little steam issuing from crevices, etc., and much of the way the ground is warm just beneath the surface, but I saw at no point any large accumulation of sulphur, although it is stated in Vol. I, Geological Survey Report, page 94, that "quite extensive deposits of sulphur occur farther down the cañon, and are known as the 'Sulphur Banks.'"

About half a mile below the Geyser Hotel, there is in Pluton Cañon a heavy mass of thin-bedded, jaspery shales whose general strike is northwesterly and dip northeasterly, but which are very much contorted, being so bent in one place as to suggest a concentric shelly structure.

The road from the Geysers to Calistoga follows up Pluton Cañon for some four or five miles before it climbs the ridge to the south.

The Little Geysers are about a quarter of a mile away from the road at the point where it leaves the cañon, and are on the opposite or north side of the bed of the cañon.

Near them is a stretch of a quarter of a mile, I think, within which the rocks high up on the hillsides north of the cañon have been thoroughly decomposed; and the present springs (which are almost entirely steamblowers like the Large Geysers, only on a smaller scale) are chiefly spread over a gentle slope near the bottom of a large cañon, which here widens out somewhat, but are considerably lower than the great mass of decomposed rocks in the adjacent hillsides.

Between the Geysers and the Little Geysers the belt of solfataric action is only to be traced by occasional spots of whitish, decomposed rocks, which are visible from the road. But these are enough to mark its continuance, as nothing of the kind was elsewhere seen in the adjacent country.

This action has taken place chiefly on the north side of the bed of Pluton Cañon, but has not been entirely confined to it, as there are a few spots lower down on the south side, which show more or less of the results of a similar action.

It will be seen that this curious belt of solfataric action is at least six or seven miles in length. It would be interesting to know whether there is any trace of gold in the sulphide of iron which is forming here.

The whole now reminds me strongly, in some respects, of the belt of

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decomposed auriferous slates in Calaveras County, in which occurs the Quail Hill Mine.

Between Cloverdale and the Geysers there are said to be two abandoned quicksilver mines; also, a deposit of sulphur which has been worked to some extent in years past, but is now idle; also, about two or three miles west of the Geysers, and something like a mile and a quarter south of the stage road, a deposit of chromic iron is said to have been prospected to some extent, but never much worked.

Mr. I. E. Shaw, President of the bank at Cloverdale, states that at a locality some seven or eight miles northwesterly from that town there is a considerable deposit of rich manganese ore, which, however, has never yet been much worked.

A little gold is also said to have been found almost everywhere in the gulches among the hills for a considerable distance both north and south of Cloverdale, on both sides of the Russian River Valley; and it is said that at a few localities considerable placer mining was once done, although it never paid much more than ordinary wages.

Mr. Menihan, proprietor of the United States Hotel at Cloverdale, states that the "coal" which was supposed to exist on the land of the late Mrs. Peck near that town, is in reality a soft, black metamorphic clay-shale full of slickensides.

Analyses of the waters of Litton's Springs, and also of Skagg's Springs, may be found in the Eighth Annual Report of the State Mineralogist, page 634.

Litton's Springs, which are cold, are situated about four miles northerly from Healdsburg in the eastern edge of the range of comparatively low hills which lies between the valley of Dry Creek on the west and the main valley of Russian River on the east. These hills, so far as seen, *i. e.*, for a distance of eight or ten miles at least, appear to consist entirely of gravel, no rock being seen there in place.

Skagg's Springs are about fourteen miles by the road northwesterly from Healdsburg, and are in the mountains about three miles west of the head of Dry Creek Valley.

Following the road from Healdsburg to Skagg's Springs, no rocks of any kind are seen in place until we reach the bridge across Dry Creek, near the head of the valley, and a little below the mouth of "Warm Spring Creek," on which the springs are located some three miles farther up. Here we strike metamorphic blocky sandstone, and from thence to the springs the rocks are all metamorphic and the stratification obliterated. They consist of blocky sandstones and clay shales, the latter filled with slickensides, and in some places great quantities of serpentine. The temperature of the warm springs here is about 120 degrees Fahrenheit, and the water certainly contains some free sulphuretted hydrogen, and also a considerable quantity of free carbonic acid, neither of which appear to have been determined in Professor Hilgard's analysis above referred to.

The locality is a delightful one, and there is a fine hotel here which appears to be well patronized.

There is also a large hotel at Litton's Springs, but at the time of my visit it was closed.

Going easterly from Santa Rosa, at Appleby's Saloon, some two miles from town, we strike a range of hills which run thence some five or six miles northerly, and seem to consist entirely of basalt. Immense

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quantities of street-paving blocks have been obtained from both sides of this range along its entire length. Near its northern end, on the lower slope of the higher mountains northeast of it, and about six miles from town, there are also very extensive block quarries.

About one mile south of Appleby's, and some three miles from town, there is another locality which has yielded a very large quantity of blocks. But the rock here is not basalt. It is a fine-grained, stratified, porphyritic, dark gray trachyte. Near these block quarries the same kind of rock has been quarried to some extent for curbing stones, and slabs, or blocks of it eight to ten feet long by one foot to eighteen inches wide, and six to eight inches thick, are here easily split out with plugs and feathers. This rock, though somewhat vesicular, is nevertheless hard and strong, and would make a fair quality of building stone.

Altogether, this region, some six or seven miles in length, has probably furnished several millions of street-paving blocks.

About two miles south of Santa Rosa are Taylor's Springs, where there is a nice hotel, with cottages, groves, etc., making a very pleasant resort, with one cold sulphur spring.

All the rocks seen in place along the cañon of Mark West Creek, for a distance of some four and one half miles up to the Mark West Springs Hotel, are volcanic and mostly basaltic. But trachytic rocks appear occasionally, and there are also here and there great quantities of more or less consolidated volcanic ash rock.

The supposed "coal field" in Taylor Mountain, referred to at the top of page 634, of the Eighth Annual Report of the State Mineralogist, is located in the mountain just back of Taylor's Springs, from two and one half to three miles in an air line southeasterly from Santa Rosa.

It has a somewhat peculiar history. For a number of years, from about 1877 to about 1882 or 1883, it attracted considerable attention, and a large amount of work was done there, a total aggregate of, perhaps, something like two thousand feet of tunnels, slopes, and shafts having been driven and sunk. During these years, also, it was visited, examined, and reported upon by various parties, among whom was the honorable and venerable Sherman Day, since deceased, one of the earliest mining engineers on the Pacific Coast, and at one time United States Surveyor-General for the State of California.

Copies of several of these reports, that of General Day included, lie before me as I write. They are too long to reproduce here. But the following short summarized statement may be made concerning them:

From the report of General Day (which was made in 1879, and was not intended for publication) it emphatically appears that he considered not only that all the work which had been done up to that time was merely in the nature of "prospecting," but also that a great deal more "prospecting" work would be required before it could be demonstrated whether it would pay to work that coal. Some of the other reports paint the field in glowing colors, evidently far exceeding anything which the developments at that time could justify.

How much good coal was ever found here is a very doubtful question, but that *some* was found, is certain; for General Day, in his report, states that in two different places he saw "a vein of good, pure coal about two to two and a half feet thick."

According to some of the other reports there are here three or four beds of good coal, which strike about north 50 degrees west magnetic,

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runs for a short distance up the valley of the Russian River to the mouth of "Dutch Bill's Creek," whose cañon it then follows up to Howard's Station, which is the highest point on the road, and is said to be six hundred and forty feet above the sea. The rocks along the road throughout this distance are all metamorphic. They consist of sandstones, clay shales, serpentine, hornblendic and jaspery rocks, etc. The greater portion of them are sandstones, but in some places the quantities of serpentine are very great. The mountains are very steep and rough. A very little gold, copper, and quicksilver are said to have been found in some places, and there has also been some talk of coal; but nothing of any value has been discovered. The timber has been the wealth of this region.

At a point two hundred or three hundred yards from Howard's Station a rock occurs which some have supposed to be basalt; but it is not. It is a very highly metamorphosed, dark-colored, hard and tough hornblendic and micaceous schist.

In the hills east of Howard's Station there is a large quantity of serpentine, but farther south, and within a radius of one and one half miles north and northeast from Freestone Station, there is an extensive deposit of bluish and yellowish white volcanic ash rock, or tufa, in which are found occasional fragments of older volcanic rocks. This tufa is too soft to be used as a building stone, but has been used to some extent for chimneys and fireplaces, being very infusible. It is from this tufa that the town was named "Freestone."

From Tomales Station I took a long drive to the eastward, along the road to Petaluma, then across northwesterly to a point some six or seven miles from town, and returned by a different road from the first one. A great deal of rock was seen on the way, but it almost all consists of highly metamorphosed sandstones and pebbly conglomerates in which the stratification is generally obliterated. No volcanic rocks were seen. Scattered about on the tops of some of the hills, however, are here and there small patches of very soft and recent sandstones, and a good deal of the surface is strewn with minute fragments of marine shells.

Dickson's basalt block quarry lies about five miles north 25 degrees east from Petaluma, and is the most southeasterly quarry of basalt blocks that I yet know of in the Sonoma hills. It has furnished large quantities of blocks.

John Lynch's quarry is some three miles or more northwesterly from Dickson's, in the same range of hills; both of them are basalt. At Lynch's quarry, some six miles nearly north from Petaluma, larger blocks of uncracked and unseamed stone can be obtained than at any other basalt quarry that I know of. But it has this serious fault, viz.: it varies greatly and irregularly in quality and texture. Some of it is very fine-grained and compact, and would make a beautiful building stone. But some of it is very vesicular or cellular, and some of it even scoriaceous in character, and not infrequently these different varieties are inextricably mixed up in the same huge block so that it would be costly to separate them.

From localities at and about Penn's Grove, some four or five miles northwest of Petaluma, great quantities of street-paving blocks have also been shipped.

The hill just back of Rudesill's Landing, some two miles southeast of Petaluma, has also furnished very large quantities of basalt blocks; and

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it is this locality which furnished the first basalt blocks that were ever laid in the streets of San Francisco.

During the latter part of the month of May, 1890, the left lower jawbone and portions of both tusks of a mastodon were dug out of the bed of a creek on the land of Mr. Andrew Ducker at a point some four or four and a half miles in an air line north 65 degrees east magnetic netic from Petaluma. These remains are now exhibited in the show window of Mr. J. C. Scott, in Petaluma. The jawbone is pretty well preserved and measures thirty-one inches in length. It contained the back molar tooth entire, together with about half of the next tooth in front of it, which was broken in two.

The tusks were not so well preserved, being very fragile, and exposure to the air since their excavation has rapidly rendered them more so. By dint, however, of the greatest care and patience, and by skillfully surrounding it with a perfect network of strong cord and then securing it to a redwood board, Mr. Ducker succeeded in holding it in its proper shape and bringing into town the greater part of the length of one of the tusks, and a portion of the other. The extreme length of the longest piece as it now lies in Mr. Scott's window is seventy-six inches, measured on the outer curve, while at a point eight inches from its present butt it is twenty and one half inches in circumference, and seventy-one inches from the butt it is twelve inches in circumference. Its weight, including the board to which it is secured, is ninety-one pounds. But a portion, probably a foot or more in length, is missing from the tip of the tusk, and some is also missing from the root; so that it seems not improbable that its total original length may have been nearly if not quite nine feet.

The portion saved of the other tusk measures thirty-five inches along the outer curve, and is nine inches in circumference nearest the tip, and nineteen inches at the larger end. It is evidently somewhat less than half the total length of the tusk.

The bed of the creek where they were found is now twenty feet or more below the surface of the adjacent nearly level land, and Mr. Ducker states that almost the whole of this depth has been excavated by the creek itself within the last thirty years, as when he first came to the country he "could jump across it almost anywhere."

The remains were imbedded in a yellowish sandy clay overlying a soft and somewhat carbonaceous sandstone, and overlaid by clays and adobe soil. Near them, and at about the same depth below the surface of the ground, is a partially carbonized tree a foot or more in diameter. The underlying sandstone, besides being generally more or less impregnated with carbonaceous matter, contains bits and bunches here and there of mineral charcoal.

The locality is perhaps a third of a mile down the creek from Mr. Ducker's house, and is close to where a solitary oak tree of considerable size stands on the slope of the low hill on the left bank of the creek.

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STANISLAUS COUNTY.

By W. L. Watts, Field Assistant.

As is well known, Stanislaus County is one of the principal agricultural counties in the State, and its mining interests are confined to the hills upon its southwestern and northeastern boundaries.

The efforts to develop the quicksilver mines, which from time to time have been discovered in the southwestern hills, do not appear to have been backed by any large amount of capital; and should a closer inquiry be instituted with regard to quicksilver ores, the quicksilver of Stanislaus County may yet become a feature in the metallurgical statistics of the State.

The superficial strata of the valley lands much resemble those of San Joaquin County, and there is every reason to believe that a boring of two thousand feet, or less, would develop a similar supply of inflammable gas to that already utilized by her northern neighbor.

Hereto appended will be found a record of items of mineralogical interest developed in Stanislaus County up to the present time, and a description of the water-bearing strata, as far as available information will permit, together with a brief mention of the various irrigation enterprises in operation and in process of construction. With regard to the latter, it will be interesting to observe the effect of spreading so large a volume of water upon the land, and to note the changes produced by the surface and sub-irrigation, in the water plane, in the character of the superficial strata, and in the vegetable growth.

QUICKSILVER.

About twelve years ago, there was much excitement with regard to quicksilver on the North and South Forks of the Orestimba Creek. Quite a little work was done and several locations were made in the neighborhood, notably at the Orestimba and International Mines.

The International Mine is on the South Fork of the Orestimba Creek; two tunnels were run upon the lead; a small furnace and retorts were built, and some quicksilver extracted, but the work was abandoned when quicksilver dropped to 40 cents per pound.

At the Orestimba Claim, on the North Fork of the Orestimba Creek, $1,000 was spent in prospecting, but no large bodies of ore were discovered. There were several other prospect workings in the vicinity of these creeks.

Quicksilver mining has also been carried on at the headwaters of Adobe Creek. A mine was opened there about four years ago and some quicksilver reduced; work was continued up to 1888. At the Summit Mine, in T. 6 S., R. 5 E., M. D. M., a shaft was sunk to a depth of seventy or eighty feet, and work was continued for about four years. This mine is on the divide, near the line between Santa Clara and Stanislaus Counties.

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Stanislaus River; upon the south side it has been mined to some extent upon the ranch of H. B. Pentland; and, as upon the opposite side of the river, the ochre is capped with oxide of iron, above which is a light-colored metamorphosed sandstone, which might be valuable as building material.

BRICKS.

In 1889 a brick yard was started on the west bank of the San Joaquin River, about four miles northwest of Grayson. The material is obtained from a yellow clayey formation. The bricks are burned in open-field kilns. The best assorted bricks are supplied from the kilns at $9 per thousand, and find a ready market in Stockton.

A fine quality of brick is also manufactured for local use in the vicinity of Modesto, also a short distance from the town of Newman.

FLOWING WELLS.

The area throughout which flowing wells can be obtained in Stanislaus County, as far as present development has determined, appears to be restricted to the vicinity of the San Joaquin River, upon the southeastern margin of the county, except where springs have been struck by comparatively shallow borings near the foothills. Commencing at Crow's Landing, the area of flowing wells follows the river to Hill's Ferry; but close to the San Joaquin the water from the flowing wells is said not to be very good.

From Hill's Ferry the area throughout which flowing wells have been obtained extends westward for about five miles, and then toward Newman and Crow's Landing. Upon the eastern side of the San Joaquin the area appears to commence on the Mitchell Ranch, near Crow's Landing, whence it stretches along the river towards the southeastern edge of the county, but the water is said to be saline. Farther down the river than Crow's Landing no flowing wells have yet been obtained; indeed, there is reason to believe that flowing water could only be obtained toward the northwest edge of the county by boring to a great depth, for across the county line, in the vicinity of Banta, a well is said to have been bored to a depth of seven hundred feet without obtaining flowing water.

The seven-inch well at Hill's Ferry, bored about ten years ago, penetrated the following formations:

Character of Strata.	Thickness of Strata, in feet.
Soil	8
Sand and yellow clay, mixed with iron-stained cobblestones and drift	100
Blue clay	65
Sand and flowing water, which flowed a quarter of an inch above the surface	5
Blue clay	20

Sand with more water; flow increased to an inch above the surface of the ground.

There is also a seven-inch well on the Winters Ranch, three hundred and twenty-five feet deep, which flows three quarters of an inch above the surface of the ground; and there is an eight-inch well on the Wilson Ranch, about one and a half miles north of Newman, four hundred and

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On the flats near the Tuolumne River, good water is obtained at a depth of from fifteen to twenty-five feet. Toward Ceres and the southern edge of the county, and towards Salida, strata penetrated by wells correspond pretty much to those observed around Modesto, save that the first water is struck at Ceres at forty-six feet, and at Turlock at twenty-two feet. Similar inconvenience is experienced from quicksand. In boring seven miles west from La Grange, in the Turlock Irrigation District, the following formation has been observed:

Character of Soil.	Thickness of Strata, in feet.
Dark adobe soil	1
Reddish adobe	3
Soft gray sandrock	20
Hard white stratum, called by the well borers "lava" (a specimen said to be similar was white clayey conglomerate)	10
Cement	10
Hard white stratum	20
Dry gravel	3
Clay, grayish when wet, white when dry	15
Sand, black when wet, blue when dry	12
First water.	
Gray cement	4
More water rose seven or eight feet in pipe.	
Black cement and sand, in strata about an inch thick	15
Gravel, with water	2
Black sand, packed very hard	28
Gravel, penetrated two feet.	

The water, which had previously stood at a depth of a hundred and eight feet from the surface, here fell to one hundred and sixteen feet. The well yielded a good supply of water by pumping.

West from Salida it is nearly all sand to the first water, which is struck at a depth of about twenty-two feet.

Typical section showing water-bearing strata west of Salida, towards the San Joaquin River:

Character of Strata.	Thickness of Strata, in feet.
Sand	22
First water.	
Grayish clay	1
Quicksand	3 to 4
Grayish clay	1
Quicksand, alternating with grayish clay	70

At this depth, which is usually something less than one hundred feet, a good supply of water is obtained.

As the San Joaquin River is approached the depth of the wells decreases. Thus, at a point on the east side of the San Joaquin River, about five miles from Grayson, an abundant supply of water can be obtained, even during the driest season, at a depth of about eighteen feet. A sandy soil is penetrated for from three to five feet, and then a hardpan of two and a half to three feet; quicksand is then passed through for about sixty feet, at which depth there is plenty of good water. A false bottom of gravel is dropped into the well to rest the casing upon, and about three feet at the lower end of the casing is filled with gravel to keep the quicksand from rising with the water.

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subsoil of the depression between these ridges of elevated land. The ridges of gravel and debris are themselves covered with a layer of sandy clay and soil of variable depth.

The following is a typical section showing the formation on the west side of San Joaquin River, in this county, except close to the river bank, where a difference has frequently been observed:

Character of Strata.	Thickness of Strata, in feet.
Gravel and drift from creeks, covered with surface soil of sandy clay, of variable depths (this only occurs in the elevated land on either side of the creek)	10 to 20
Soil, clayey and sandy loam	2 to 6
Sandy soil, becoming clayey as water is approached	20 to 125
Potable water; but usually hard.	
Tough, yellow, reddish, or bluish clay	40 to 50
Gravel yielding a good supply of water—enough for a windmill pump	4 to 6
Alternate strata of reddish clay and gravel, and sand the clay being about twenty feet thick and the gravel and sand four to six feet	50 to 120

There are naturally some local exceptions, but such are the general features of the superficial strata on the western side of the county, between the San Joaquin River and the western hills, especially from Newman northward to the San Joaquin County line.

In boring a well for the waterworks at Newman the following formation was passed through:

Character of Strata.	Thickness of Strata, in feet.
Clayey and sandy loam	3
Hard "alkali" and hardpan	3
Yellowish sand	3
"Alkali" water.	
Yellow clay	7
Sand and gravel, with water.	

From this point alternate strata of sand, gravel, and clay, estimated to a depth of about two hundred feet. The sand and gravel contain water. The best water is said to be obtained at a depth of from eighty to one hundred feet.

A short distance south of Orestimba Creek, where it enters the San Joaquin, quicksand is struck at a depth of about fifteen feet, and has been penetrated to a depth of one hundred and sixty feet. This quicksand extends about five miles down the river from the mouth of the Orestimba, and for a distance of some three or four miles to the east of the San Joaquin, where it has been frequently penetrated to a depth of one hundred feet. Beneath the quicksand is a stratum of blue clay, affording a good support for the casing. Where the clay is not reached a false bottom of gravel has to be put in the well, and the lower end of the casing filled with gravel for a distance of seven or eight feet.

"Alkali" water has been encountered on the west side of the San Joaquin near Hill's Ferry, also close to Newman, in blue clay, at a depth of about thirty feet. This "alkali" water is cased off with galvanized iron pipe, and good water is obtained in a stratum of gravel at a depth of about sixty feet.

The "alkali" water is generally found in shallow strata of blue clay, either in the clay itself or in the strata of sand by which it is traversed.

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Along the banks of the San Joaquin the blue clay usually overlies a quicksand, beneath which is a stratum of clay overlying a gravel, which yields a good supply of potable water.

Near the river on the northern edge of the county, and extending into San Joaquin, quicksand is again a prevailing feature of the superficial strata, and the following formation has been observed:

Character of Strata.	Thickness of Strata, in feet.
Sandy soil	2 to 4
Quicksand, variable	30 to 8
Blue clay	12
Quicksand containing bitter "alkali" water	4 to 50
Blue clay	5 to 10
Gravel containing good potable water.	

In the cañons in the western foothills alternate strata of sand and loam have been passed through to a depth of about one hundred and twenty-five feet. At that depth a quicksand has been frequently struck which yields sufficient water to supply a windmill pump. In many instances, in place of putting a false bottom of sand and gravel in the well, water has been utilized from a quicksand formation by employing a casing closed at the bottom, with small slits in the side, which allowed a passage for the water but kept out the quicksand, the casing being supported by the strata it penetrated nearer the surface of the ground.

A well was bored on the ranch of David Hayes, about thirteen miles northwest from Newman, in a cañon in the foothills, and the following formation was observed:

Character of Strata.	Thickness of Strata, in feet.
Soil	3
Grayish clay, intercalated with yellow sand, passing into blackish clay	90
From this formation a small amount of fairly good water was struck at a depth of about forty feet.	
Grayish sand	160
"Soapy feeling" rock, passing into shale, which became highly fissile and caved badly	240

The shale contained a supply of water sufficient for a windmill pump, but it was brackish and "only fit for watering stock." In the stratum of shale a seam of coal about two feet thick was bored through, and several smaller veins only a few inches in thickness. At a depth of a little over four hundred feet a thin stratum of pebbles was also noticed which yielded a little water.

IRRIGATION.

There are five different irrigation systems in Stanislaus County, two of which, namely, the San Joaquin and Kings River, and the San Joaquin Land and Water Company, are in operation; and three, namely, the Turlock, the Modesto, and Oakdale irrigating systems, are in process of construction.

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feet of water per second. The dam is about one hundred and sixty-four feet above sea level, and about fifteen feet above Oakdale, which is eleven miles distant.

The company intend to run their canal to Oakdale, between which point and the dam lateral ditches will extend for the purpose of irrigation. The canal will be continued about ten miles below Oakdale, towards Salida, and from it ramifications will extend throughout the surrounding country. It is estimated that about fifteen thousand acres will be covered by this system of irrigation. Some eight miles of ditch are now completed. The cutting has been through cement, sandstone, hardpan, gravel, clay, and alluvial soil. There is also over a quarter of a mile of tunnel, which has been completed.

An Indian mortar was found in a bed of cobblestones and gravel at a depth of about ten feet beneath the surface of the ground.

The Pentland Water Right.

There is also some talk of reconstructing the irrigation system depending upon the water right of H. B. Pentland, which commences at Six-Mile Bar.

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TEHAMA COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

Little mining is being done in this county at present. In former days some river mining was carried on in the upper reaches of the Sacramento River, which runs through the county, but that has pretty well ceased, and the only kind done, to speak of, is near the western boundary of the county, in the Coast Range Mountains, where some large deposits of chrome iron are being developed, the ore being shipped to Philadelphia. The town of Red Bluff, the county seat, lies at the head of river navigation on the Sacramento. The county itself, which comprises an area of three thousand two hundred square miles, is about evenly divided on both sides of the river. Geologically considered, the eastern half of the county is covered with sheets of lava-flows, covering one another until the whole have a stratified appearance, which have had their origin from and around Lassen's Peak, with some assistance from smaller craters scattered along the route. Along the river itself, on both banks, are Quaternary deposits, but on a lower level by about fifty feet than the surrounding country, which, on the west side of the river, shows an extended plateau of gravels, sands, and clay for a distance of nearly thirty miles to the serpentines and metamorphic rocks of the Coast Range which run along the border of the county between it and Mendocino and Trinity Counties. Through this plateau the Red Bank and other streams have cut deep channels on their way to the Sacramento River. It is in this part of the county, in Secs. 13 and 14, T. 26 N., R. 8 W., that Messrs. Hensley and Hazlewood are working some chrome iron deposits.

TEHAMA CONSOLIDATED CHROME MINE.

These deposits were located in 1886. They consist of separate bodies inclosed in the serpentine; ten or twelve such bodies are known. The ground has been taken up as a surface claim covering six hundred and forty acres. The largest of the bodies as far as known is about sixty feet long and sixty feet broad. These bodies are worked as quarries. The owners have leased the property, and receive \$2 per ton; the lessee gets the chrome broke on contract for \$1 per ton; the method employed by those who do the breaking involves a good deal of handling that, it would seem, might be avoided. The country rock is serpentine. Where blasting is required they use Giant powder, both No. 1 and No. 2; it takes about five hundred pounds a year. The company have built about seven miles of road to enable them to get the ore to the railroad. They have to pay \$4 75 per ton for freightage to the cars, \$3 50 per ton on the railroad to San Francisco, and \$5 per ton by vessel to Philadelphia; there it is sold and worked. Wages are \$2 and board for miners, and for outside work \$1 50 and board. They employ twenty-five men all told, but a large part of them are at work building roads. The location has an altitude of about two thousand feet.

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nice specimens of which can be obtained here. With the waters gas escapes, which used to be collected and utilized in heating the baths, but is allowed to escape at present. The springs and the mud that exudes around them, are used medicinally, and have quite a reputation for the cure of rheumatism, kidney and liver disorders, and skin diseases. The waters contain borax, iodine, lithia, magnesia, potassium, sodium, and sulphur; the latter is found in and around the springs as red and yellow sulphur. Experts claim that the prospects for striking a large body of gas here are extremely favorable; also, oil somewhat to the east of this place, as the formation is stated to be in range with, and very similar to the formations in Trinity and Humboldt Counties, where oil is found. These springs are about five hundred feet higher than the town of Red Bluff.

North of the chrome mines a good quality of coal is said to have been found. The exact locality of which, however, was withheld. Quartz, with gold, was also reported as having been found northwest of the chrome mines.

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gold, are being prospected and worked in different sections; others that have been opened and worked for several years have yielded and are yielding handsome returns to the owners. Cinnabar, chrome iron, coal (lignite), and limestone are found in several townships of the county. The small streams heading in the high ranges of the Scott, Trinity, and Salmon Ranges of the north among the numerous lakes form the headwaters of the Trinity.

The Trinity River in its course southerly presents evidence of the great erosive power of the flowing waters. From the section where Coffee Creek, one of the main tributaries, flows into the Trinity, the great banks of auriferous gravel commence, parallel with the present river as far as Swift Creek, in Sec. 9, T. 36 N., R. 7 W. The bed of the river formerly flowed west of the town of Trinity Center, at an elevation of several hundred feet above its present channel, thence taking a southwesterly course through the range of mountains known as the Buckeye Range (T. 34 N., R. 9 W.) on to Weaver Basin (T. 33 N., R. 9 and 10 W.). Through this section, Trinity Center to Weaver Basin, is presented the only evidence of ancient river channels, the ancient river emptying into a great lake at the present Weaver Basin.

The auriferous material of the Ward Mine, on Oregon Gulch, and that of Dutton's Creek (T. 33 N., R. 10 W.) has the appearance of being identical with that of the channel on the Buckeye and Brown's Mountains. The material filling this channel is composed of volcanic breccia and rocks of all formations and ages; angular, irregular, rounded, and triturated, with conglomerates, clay, and sands. The bed of this ancient stream is several hundred feet above the present river bed of the Trinity, as well as that of Weaver Basin. The water lines and sedimentary deposits on the mountain sides illustrate the great depth of the waters of the lake and their outlet through the Oregon Mountain Range, the natural and direct course to the channel of the Trinity, in T. 33 N., R 11 W., the present site of Junction City.

The bed of Weaver Basin is a cement, several hundred feet in thickness, below the auriferous gravel deposited from the ferruginous, siliceous, and calcareous matter carried down by the waters, erosions of the various formations along the channel settling in the basin there cementing. The absence of coarse material leads to the hypothesis that this cementation took place prior to the filling of the cement channel with auriferous sands and gravel. The northern bedrock of the Ward Mine with its gradual inclination toward the south from the divide on Oregon Gulch, the western rim of the basin—smoothly polished, the angular and irregular material forming the auriferous covering to the depth of from fifty to several hundred feet, with the disturbed appearance of the southern rim of the mine, broken, shattered, and crushed as though some great pressure had been thrown against it from the northeast—points to a greater power than that of flowing water, leaving the impression of glacial action.

The filling of the channel, the deposits of debris in the lake upon the cement, and the final closing of the Oregon Gulch outlet, forced the waters over the divide to the south, the present Weaver Creek channel, the waters having eroded the channel to its present level through the soft rocks of talc and schistose slates of that section. The modern streams formed from the "resistless erosive power of water" received their auriferous filling from the detrital accumulations of the ancient

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channel above, carried by the rushing waters from the snow-clad mountains in their course toward the depressions, cutting the formations and the old river channel.

These depressions, by the constant "erosive power," forming the modern river, the Trinity. The waters cutting and forcing their way through the softer rocks, mainly chloritic and talcose slates, forced to meander in their course by encountering the harder rocks of the primitive formations, present a series of curves from convex to concave, in which the auriferous gravels and sands are deposited. Along portions of the channel, where there is but a slight inclination to the bedrock, the finer material settled in the channel, forming the shallow placers; again, in several townships through which the river flows, the waters have forced and carried their passage through the formation, forming deep and precipitous gorges; now and again coming in contact with the harder rocks, plunging over them, forming waterfalls and rapids, depositing no material, carrying all beyond to where the channel forms again its circuitous and less precipitous course. Thus the channel of the Trinity River presents, alternately, barren sections and gravel deposits. (Reference made to geological map of Trinity, illustrating gravel deposits and ancient channel; also, to Plate VIII.)

COFFEE CREEK.

This is one of the main tributaries of the Trinity, heading in the Granite Mountains of the Salmon Range and flowing easterly through Townships 37 and 38.

Between the headwaters of the creek and the Salmon River, in Siskiyou County, there are large meadows with numerous springs from which water empties into both streams. The topography of this section indicates that the Salmon River formerly had an outlet through Coffee Creek channel to the valley of the Trinity.

River or stream mining has been carried on for years in the channels of Coffee Creek and tributaries, working the shallow deposits of gravel of the bed, the bars, and the banks. Adams & Manyana (Frenchmen) during the past twenty years have been engaged in mining the bed of Union Creek, a tributary of Coffee Creek, in T. 37 and 38 N., R. 9 W. They began operations at the mouth of the stream, having systematically followed up the channel. The bedrock of slate is very uneven, upon which rest great bowlders of granite from the mountain sides and ranges above. Derricks are operated to remove all bowlders and rocks; water from dam thrown across creek above present works is conveyed by ditch and flume to the sluices. The gold found is generally coarse, from a few cents to nuggets of as high as $50.

The large deposits of gravel on Coffee Creek are patented to J. E. Carr, and are operated by the

NASH DEEP GRAVEL GOLD MINE COMPANY.

There are six hundred and forty-nine and thirty-seven one hundredths acres patented, and thirty acres secured by location. The claim commences fifteen miles above the mouth of the creek, embracing a narrow strip of land following up the creek to the meadows. This property is in T. 38 N., R. 9 W. The projected tunnel is to pass from the lower

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end through the point where the creek makes an abrupt turn, a distance of about three hundred feet; this will secure a fall of about forty-six feet. By the proposed tunnel, a race for tailings would be secured with the above mentioned fall.

Bowlders: Large and small, with sand and clay; no cement.

Gold: Coarse; valued at $18 per ounce.

Gravel: Deposit fifteen feet; gold mainly on bedrock.

Water: By ditches from the main tributary of Coffee Creek; ditch of two and one half miles across meadows to Salmon Creek would furnish sufficient water for four or five monitors.

Average yield of three eighths of an acre amounts to one thousand two hundred and forty-three ounces, at $18 per ounce, gives a value of $22,498 30.

THE BLYTHE PROPERTY AND DITCHES

Are situated on upper bench, west side of Trinity, in Secs. 19 and 20, T. 37 N., R. 7 W., below Coffee Creek. Auriferous gravel from Coffee Creek upper channel; one hundred and fifty-five and eighty-six one hundredths acres patented. There were many locations of gravel land made by Mr. Blythe between his patented land in Trinity Center, a ditch having been surveyed and partially constructed, commencing upon Coffee Creek at the Big Bowlders; thence down Sugar Pine Creek across to Morrison Gulch, about one mile above the mouth of Coffee Creek; thence on the bench on the west side of Trinity River, with the intention of working the auriferous gravels of the old channel between Coffee Creek and Trinity Center. Nothing is being done at present on this property.

TRINITY CENTER MINING DISTRICT.

(See Plate III.) This district was settled in 1851, and became a noted camp in 1853, and is known for the richness of its auriferous gravel. From the last mentioned date the deposits have been worked yearly during the water seasons. The deposits of gravel are in the form of benches—old channels. The flow of waters originally having been high up in the mountains to the west of the present channel, the upper channel filled with detritus and debris. The waters having cut through the soft rim of clay slates, formed a lower channel, and so on, the present river channel, encountering the harder rocks, metamorphic gneiss, and hornblende schists, forming the present eastern wall of the Trinity along that section. This belt of gravel is about three fourths of a mile in width, varying from twenty feet on the lower benches to eighty feet on the upper benches in depth, being a section of the "flow" of gravel from Coffee Creek to the Weaver Basin.

THE HASKIN CLAIMS (HYDRAULIC)

Comprise the Hatchet Creek Claim of fifty-four acres and the Haskin Claim of eighteen acres (see plate). They are located on Hatchet Creek, Sec. 32, T. 37 N., R. 7 W., and Sec. 5, T. 36 N., R. 7 W., M. D. M; river gravel and creek wash. Hatchet Creek having forced its course through the gravel benches from the west to the present river bed, the gold of the gravels concentrated in the creek beds, and yielded rich returns to the early miners who worked the bed of the stream. This creek divides

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Pipe: One thousand nine hundred feet, fifteen and thirteen inches in diameter.

Monitors: Two, Nos. 1 and 2; nozzles, three inches and four inches.

Sluices on claim: Twenty-five boxes, six by three feet; grade, three and one half inches to twelve feet. Lower sluice for tailings, thirty-five boxes twelve feet each; two-inch grade. No undercurrent. Paving of sluice boxes eight inches thick.

Gold mainly recovered from ground sluice; balance from first five boxes. Value, $18 15 per ounce.

Amount of ground worked to date, sixteen acres.

In connection with this property are five lakes: Lake Elna; elevation, four thousand eight hundred and sixty feet. Two lakes not named; elevation, four thousand eight hundred and twenty feet. Bear Lake; elevation, four thousand five hundred feet. Meadows Lake; elevation, four thousand two hundred feet. Deer Lake; elevation, three thousand five hundred and sixty feet. Angle Lake; elevation, three thousand four hundred and ten feet. The waters of the two last mentioned lakes find their way into the upper ditch. Lake Elna is one thousand feet in diameter and of unknown depth.

The company proposes the erection of a dam between the ridges three hundred feet long by fifteen feet high in center, the average height to build not exceeding five feet, and thus secure storage for sufficient water from the mountain streams feeding the lake to furnish water during a season of ten months to run double their present number of giants. From the dam a ditch is to be built for one and one fourth miles, conducting the waters into a deep cañon leading into head of upper ditch. Elevation of lake above head of upper ditch is eight hundred and eighty-five feet.

THE COYLE MINE (HYDRAULIC)

Comprises seventy-six and twenty-seven hundredths acres of benches, and forty acres of flat. The average depth of gravel is sixty feet. The yield of gravel per cubic yard is 20 cents, and the yield of gravel per acre is $19,360. Water is obtained from Swift Creek, one third of Bloss & McClary's lower ditch, and from a small ditch below the Bloss & McClary Ditch. The pressure from reservoir is one hundred and fifteen feet.

Sluices: Two hundred and eighty boxes, twelve feet in length; width, three feet; depth, three feet; and grade, three inches. A self-shooter is used, discharging from a reservoir every thirty minutes.

Pipes: One hundred feet, thirty inches in diameter; five hundred feet, fifteen inches in diameter; and two hundred feet, thirteen inches in diameter. One monitor (No. 3) with five-inch nozzle.

The derrick is worked by overshot wheel, ten by three and one half feet. All bowlders and large rock are raised by the derrick and stored in claim.

Amount of water required, fifty inches; no blasting; season, ten months, running night and day; claim worked for the past twenty years; amount of ground worked, twenty acres; tailings run on flat; waters running into Trinity River.

There are several claims in this district, as shown on sketch Plate III, that are not being hydraulicked on account of not having water supply.

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TRINITY GOLD AND MINING COMPANY (HYDRAULIC)

Is located in Sec. 7, T. 33 N., R. 10 W., and comprises the following claims on Oregon Gulch, in mountains:

McCarty Claim	39.04 acres.
Dyer Claim	4 acres.
James Ward Placer	119.73 acres.
Oregon Gulch Placer	159.43 acres.
Loverage Placer	109.40 acres.
Total	432.30 acres.

It is situated in Oregon Gulch Mining District, four miles northwest of the town of Weaverville, and was located about 1851. It is a glacial deposit, filling the ancient channel through Oregon Mountains. These claims begin in Oregon Gulch, on west side of Oregon Mountains, with the McCarty and Dyer locations—depth of gravel at foot, about fifty feet—following up the cañon and gulch through the Ward Placer to the Oregon Placer. Crossing the mountain divide, the gravel or deposit gradually increases in thickness to an estimated depth of from five hundred to six hundred feet. Tailings are dumped into Oregon Gulch; waters discharging into the Trinity, above Junction City. Width of deposit worked at present time, about four hundred feet, following up gulch; no blasting; yield per cubic yard, 17 cents. About one thousand five hundred inches of water used; head of water, three hundred and sixty feet and two hundred and eighty feet, through different giants.

Pipe: Five hundred feet, eighteen inches in diameter, main; five hundred feet, eighteen inches in diameter, leaders; five hundred feet, thirteen inches in diameter, leaders; Nos. 12, 14, and 16 iron. Three monitors, No. 5; nozzles, five and six inches.

Sluices: Two hundred and sixty feet, eight by three feet; raise, seven inches to twelve feet; block paving, twelve inches thick; one undercurrent, twelve feet wide and forty-eight feet long; grade, sixteen inches to twelve feet; blocks, six inches thick.

Water supply from West Weaver Creek, heading in Mount Baldy. Length of season, six months.

Average daily run, two and one half hours; fineness of the gold, .895; top and bottom percentage, saved in sluices, fifty-nine sixtieths, one sixtieth in undercurrent; nine tenths saved in first eight boxes.

Claim worked during past sixteen years by hydraulics, formerly drift.

The present supply of water, as obtained from West Weaver Creek, being very limited, the company propose in the near future the introduction of water from Rush Creek, heading in the Buckeye Mountains, T. 34 N., R. 9 W., by extending the present constructed ditch about four and three fourths miles. Present length of ditch, seven miles; grade, nine feet to the mile. The company own the first water right, and expect to secure three thousand inches for from seven to eight months during the year. By extending the ditch from present terminus to Stewart's Fork, heading in T. 36 N., R. 10 W., to tap the creek at a proper elevation, would require an additional ditch of about nineteen miles, affording an unlimited supply of water throughout the year. The company have estimated their yearly runs by the hour on account of limited water, the average yield being from one of three hundred and

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thirty feet. Seven men employed during season of four months, using about three hundred inches of water under a pressure of eighty feet on present bench, the lower bench having one hundred and fifty feet. Mr. Lorenze and David Evans purchased all the water on the Connor Creek, heading in the Hay Fork Range of mountains, with the exception of twenty inches, for the sum of $25,005; thus the Evans Claim has one half the water. There is in use one monitor, with nozzle of five inches, having one thousand five hundred feet of eleven-inch pipe. About twenty thousand square feet stripped each season. Gold, fine (sample in Bureau). No quicksilver used. No accounts kept, therefore could not ascertain yield per cubic yard, but it is no doubt about the same as the Red Hill Claim.

RED HILL.

North Fork Mining District, Secs. 26, 34, 35, and 36, T. 34 N., R. 11 W. Claims:

Stoddard Placer	52.40 acres.
McGilloray Placer	582.78 acres.
Mammoth Placer	109.73 acres.
Anson Placer	36.14 acres.
Park's Bar	20.72 acres.
Nick Lorenze	5 acres.
Connor Creek	20 acres.
Sawmill Lot	55 acres.
Henry Lorenze's total	881.77 acres.

The Stoddard Placer and about three hundred acres of the McGilloray Claim are on the north side of the river, being lowland. The bed is about on a level with the present channel. Worked by elevator. Balance of mining ground on the south side of the river, forming two distinct river benches. Total mining ground, seven hundred acres; amount worked to date, about two hundred and seventy acres. On the north side the elevator has been in use until the present year, for four seasons, working ten acres from Park's Bar and two acres on the north side of the river. The elevator was of the Martin patent, and not working very satisfactorily, Mr. Henry Lorenze introduced his patent air connection. The original shape was octagonal; now altered to pentagonal, sixteen inches in diameter inside of lining, the lining being of chilled iron two inches thick, one foot wide, and three feet long, extending the full length of the elevator—forty feet. Above this there has been added an extension of plank three inches thick, twelve feet long, with an outside diameter of thirty-six inches, lined with eight-inch blocks, leaving an inside clear of sixteen inches.

The air nozzle is attached to the driving nozzle, one at the bottom of the elevator, and the other to the driving nozzle introduced by Mr. Lorenze, half way up the elevator. The ground worked is a low channel, necessitating the raising of the debris over the rim into sluices, discharging into the Trinity; pipe to elevator, three quarters of a mile, thirteen inches in diameter, No. 14 iron; nozzle, five inches. Pipe for monitor and sluices, three quarters of a mile, eleven inches in diameter, No. 14 iron; nozzles, four to five inches. Deposit of gravel at Park's Bar is twenty feet thick; average yield, 4 cents a square foot. The deposit of McGilloray Claim at elevator is thirty feet deep; 52 cents a cubic yard. In the McGilloray Claim the gravel is elevated forty-nine

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feet; in Park's Bar Claim, thirty feet; class of gravel, river wash; some sand and clay, occasionally cement on bedrock from eighteen to twenty inches thick. Formation of bedrock, slate and soft porphyry. The heavy storms of the past winter filled the elevator pit with wash from the back lands; therefore, during my visit, the elevator was not running, the owners, however, stating that as soon as the waters receded they would open up the pit and resume operations.

THE MAMMOTH CLAIM

Consists of one hundred and nine and seventy-three hundredths acres, located on the opposite of Trinity; operated by Messrs. Lorenze and Leibbrant; hydraulic. This deposit is river wash on high benches, there being two as far as exploited. Water from Connor Creek flows into reservoir; one monitor, nozzle, six inches; pressure of water, eighty feet; one thousand five hundred feet of pipe, and one mile of ditch; season, five months; amount of water used, six hundred inches, all through giant; no overflow sluice stream. From claim there are twenty sluice boxes through a twelve-foot undercurrent; waters falling again into four boxes, carrying into four hundred feet of bedrock tail race, thence into flume of ten boxes, the second undercurrent finally dumping on flat, the lower bench (worked out) one hundred and twenty feet above the present river bed. Average ground worked in a season, two acres; average bank, one hundred feet deep; stated yield, 22½ cents per square foot.

JACOBS BROS.' PLACERS (DRIFT).

Sec. 35, T. 33 N., R. 11 W., comprises two hundred and seven acres. Water limited; twenty inches from Connor Creek. Drifting the ground and sluicing; ground rich on bedrock, being in the same channel as Red Hill.

The following mines are located in T. 33 N., R. 11 W.; working season limited, having to depend mainly on the short ravines in the adjacent mountains:

Patterson Bar Placer—Section 35	39.73 acres.
Conrad Donnenbrink—Section 12	39.94 acres.
Red Flat Placer—Sections 12 and 13	55.32 acres.
Howell Placer—Section 13	18.89 acres.
Flowers & Birger—Sections 12 and 13	53.10 acres.

There are several others that could not be visited.

EVANS' BAR (HYDRAULIC).

Sec. 33, T. 33 N., R. 10 W., comprises sixty-five acres; Junction City District; located, 1887; bench gravel deposits; average depth, forty feet; one Giant, No. 3; nozzle, four-inch; five hundred inches of water; pressure, one hundred and sixty feet; one hundred and eighty feet of sluices; grade, eight inches; two undercurrents; water from Skunk Creek, heading in Oregon Mountains; ditches, three, from one quarter to three quarters of a mile in length; season, five months; average run, three hours daily; gold, $17 62 per ounce; average yield per season, $4,000.

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GOOD FRIDAY MINE.

(Arkansas Dam.) Sec. 20, T. 33 N., R. 10 W.; water from Oregon Mountains; season, three months; one monitor, No. 1; nozzle, three inches; depth of gravel, fifty feet; sluices and undercurrents; changing this season from hydraulic to drift on account of small water supply.

CHAPMAN & FISHER.

Secs. 19, 29, and 30, T. 33 N., R. 10 W.; comprises one hundred and thirty-eight and thirty-two hundredths acres; west bank of Trinity; Junction City District; elevation, one thousand nine hundred feet; river gravel; large bowlders; present face, eighty feet deep; deposit from bedrock, eight to ten feet coarse gravel; bands of clay overlaid with strata of sand; clay of a red color. Above the sand the large bowlders are found, some weighing many tons. Bowlders, as found in this claim, are the largest of any found along the river. There are three distinct benches of gravel; lower bench, one mile long by four hundred feet wide in center; second bench, one hundred and twenty-five feet above, width six hundred feet. Claim located in 1871; worked by hydraulics for two years with canvas hose and a two-inch nozzle under eighty feet of pressure; balance of time to date with No. 5 monitors, nozzles five and six inches; four monitors on hand; two in use; six thousand one hundred feet of pipe, fifteen inches in diameter, on claim; one hundred feet of twenty-inch pipe, and thirty feet of thirty-inch pipe, on mountain, and one thousand feet of fifteen-inch pipe branching along claim; working second bench; third bench not exploited. Sluices from bedrock drain, thirty-five boxes twelve feet long; grade, ten inches; dumping on first bench; sluices, six feet by four feet high, paved with stone blocks twelve inches thick; undercurrent, twelve feet wide, thirty-six inches long; twelve sixteenths of the gold recovered in bedrock drains, three sixteenths in sluices, and one sixteenth in undercurrent; quicksilver used in the boxes; water from Soldier's Creek, heading in the Hay Fork Mountains; season, five months; fineness of gold, .920; amount of ground worked during the season, one acre; formation, slate, on end very rough and uneven; gravel averages 32 cents per square foot. During the past nineteen years Mr. Chapman has collected from the sluices of this claim about twelve ounces of platinum, the largest piece weighing one ounce. This piece has been presented to the Mining Bureau.

D. N. CHAMBERLAIN MINE (HYDRAULIC).

Lewiston Mining District, T. 33 N., R. 8 W., on northwest bank of Trinity, at Big Bend of river; elevation, two thousand two hundred and forty feet; old river channel; width of channel, three hundred feet; depth of gravel, thirty feet; length of channel, one half mile; formation, clay slate, black; gold, fine, $17 25 per ounce; water from Brush Creek; ditch, seven miles; pressure, thirty to one hundred feet; average, sixty feet; seven hundred feet eleven to fifteen-inch pipe, No. 16 iron; one monitor, No. 4; nozzle, four and a half inches; length of season, seven months, ten hours' run daily; claim worked since 1859; amount of acres worked, thirty; three men employed; average yield per season, $7,000; all material run into bedrock drains, containing each twenty-four feet of boxes;

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EAST FORK OF THE NORTH FORK.

T. 34 and 35 N., R. 11 W., M. D. M. (Plate VII). Formation, mainly granitic gneiss and mica schists, overlying the true granite. The veins of quartz, as far as explored, indicate being incased in the strata between the primary and metamorphic rocks. In portions of this district the stratified rocks are much contorted, giving the veins very uncertain courses or dips. This is notably so in the Enterprise Mine, the vein resting on the formation as a blanket-ledge, and being very much disturbed and broken. Evidently a portion of the vein of the adjoining claims on the mountains above, that form their upper dip of about 60 degrees, have gradually flattened as they rested on the granite below, the softer rocks yielding to the action of the waters, uncovering the veins in the cañons and deep waterways. The mica of the gneiss and schist is of a silvery white (muscovite), in places the mica entering the quartz, forming a quartz schist. In such cases I notice that the vein yielded to the granitic rocks, and finally became lost. The mines of this district operating are the North Star Group, the Enterprise Group, and that of the Niagara Company, the Yellowstone Group.

THE NORTH STAR COMPANY.

The mill of this company has not been working. A new ten-stamp water-power mill was erected during the past year by parties who bonded the property. The developments during the year, since the report of 1888, were mainly on the Little Chief and Linnie ledges of the Linnie Claim.

Linnie Ledge.—Course of croppings, northwest and southeast; dip, to the west; elevation of croppings, two thousand two hundred and ten feet; the main tunnel, located about one hundred and ten feet vertical depth below croppings, has been advanced from the mountain side toward vein two hundred and forty-eight feet, the company expecting to tap vein of the Linnie within forty feet from present face; face of tunnel in granite (compact). Some distance above a drift has been run on the vein from the south end a distance of seventy-four feet; size of vein, twenty-seven inches; value of ore, $10; free gold; two inclines from croppings. No. 1, on south end, to connect with drift; depth, twenty-eight feet; vein, twenty-three inches; ore, $10. No 2, from croppings to connect main lower tunnel; depth, fifty-five feet; vein much broken and mixed with country rock, the quartz containing considerable mica.

Little Chief Vein (above the Linnie vein).—Incline on vein, eighty feet deep; drift from bottom north, ninety feet; ledge, from ten to eighteen inches; value per ton, $20 to $25; opening on the south end; ledge, twelve inches; value of ore, $12 per ton.

North Star Vein.—Tunnels connected by lateral drifts; vein from three to five feet; value of ore, from $15 to $20 per ton.

The company having developed considerable ore in their upper workings expect to start the mill in the near future.

THE ENTERPRISE.

Since last report (1888), this company has abandoned its arrastra for a ten-stamp iron frame battery, at present running on ore from their

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and Ready, Sunday, and McGinty Claims, situated on the north bank of Little East Fork Creek, a tributary of Cañon Creek; elevation from fifty to six thousand feet, the apex of range above the claim having an elevation of six thousand six hundred feet. The district is known as the Cañon Creek District. Cañon City, a small settlement, the nearest town, is connected by wagon road with Junction City, being six miles south of the mines on the creek. From Cañon City there is a trail for men and animals to the mines. Elevations: Junction City, one thousand seven hundred and five feet; Cañon City, two thousand one hundred and seventy feet; three miles on trail, two thousand six hundred feet; four and one half miles on trail, three thousand feet; at mine in district, five thousand seven hundred and ten feet; top of ridge, six thousand six hundred and sixty feet, showing a difference in elevation between the mouth of Cañon Creek at Junction City and the mines, thirteen miles up the stream, of about four thousand nine hundred feet. The distance from Cañon City to the mines is about six miles by trail, with a rise of four thousand four hundred and thirty feet. The formation of Cañon Creek from Junction up to Little East Fork is mainly a dark hornblendic schist, the land beyond being granite. At the mines the veins, as far as developed, indicate a foot wall of granite porphyry, with hornblendic slates as the hanging.

Developments are progressing on the several claims with flattering results. The main explorations to date of examination were on the Lookout Claim of the Baily-Smith Company, controlling the Mount Echo, Lookout, and Highland Claims. Within the boundaries of the claim there are three distinct croppings, two dipping about 85 degrees east, and the other 80 degrees north; course of vein, northeast and southwest. The workings are all above the lower ledge, the upper ledge being reached by tunnel from face of mountain; elevation, five thousand seven hundred feet; length of tunnel, forty feet; vein, five feet; no drifting as yet on ledge. The second vein is tapped by two tunnels, the upper one at an elevation of five thousand six hundred feet; length to ledge, twenty-seven feet. The second tunnel is at an elevation of five thousand five hundred and eighteen feet; length to ledge, seventy-six feet. This tunnel is being extended into the mountain to cut the back or upper vein. No drifting has been done on the middle ledge. The vein will average at point of intersection about four feet in thickness. From the surface down, as explored, the quartz prospects very richly in free gold, with a fair percentage of sulphurets, mainly arsenical iron. The company intends to thoroughly and systematically develop its property, and to erect in the near future a mill on Cañon Creek. The mountain sides and deep gorges are well timbered with pine and fir.

At Buck's Ranch, on the East Fork of Cañon Creek, there are large ledges of fair grade ore being worked successfully by arrastras, crushing about seven tons a day. At Fisher Gulch several locations have been made on quartz croppings, which, as prospected to date, yield sufficiently in free gold to warrant greater developments.

Cañon Creek, heading in the granitic mountains of the Salmon Range, is one of the most important tributaries of the Trinity, furnishing water power to many of the auriferous gravel benches along the river. In the days of river and bar mining the creek proved to be wonderfully rich in the channel, and in later years the high benches of gravel have and are yielding handsome returns to the miner.

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Cinnabar.—About half a mile below Cañon City, on Mogul Gulch, Sec. 6, T. 34 N., R. 10 W., cinnabar was found sixteen years ago in the hydraulic claim of Wolff Brothers. Upon uncovering the bedrock small seams of very rich ore were discovered in the slates (sample 1 sent to bureau). Considerable prospecting was carried on by tunneling the formation, but the results were unsatisfactory. From the number of strata and the general character of the formation (ferruginous slates), the section presents a favorable inducement for capital to invest in further explorations.

STUART'S FORK,

Heading in Salmon Mountains, T. 37 N., R. 10 W., and emptying into Trinity in T. 34 N., R. 9 W. During the past season, V veins from ten to twenty feet in width have been discovered on Deer Creek, Sec. 19, T. 35 N., R. 9 W.; formation, granite, with hornblendic slates. There are also through this township great belts of limestone, dolomitic, joining on the serpentine belt from the northeast. The quartz is white, containing sulphurets of arsenical iron, galena, copper, and zinc; but little free gold is detected by panning. From average samples of the vein taken this season, the assay returned by Falkneau gave gold at $12 56 and silver at $8 70 per ton, the gold being mainly contained in the sulphides.

Locations: Dark Horse, Gray Eagle, Old Buck, and Little Gem. Workings are mainly on the Dark Horse, by tunnel from creek, sixteen by seven feet in solid quartz; vein crops five hundred feet above the tunnel level; water power on Deer Creek; elevation at tunnel, five thousand three hundred feet. On Little Deer Creek, Sections 17, 18, and 19, there are large bodies of cement from sixty to two hundred and fifty feet deep, composed of quartz gravel, covering from six to eight feet of auriferous gravel lying on the bedrock. But little prospecting has been carried on in this section, or any point of the Stuart's main or tributaries for quartz or auriferous cement and gravel. This is accounted for by the fact that the stream yielded poorly in placer gold in early days. Gold was found at several points, but in limited quantities. Considering the precipitous nature of the stream—the water dashing over the rocks, no opportunities for pools or formation of bars, rocky sides forming deep and narrow gorges, through which the water poured into the Trinity—all the gold was swept along with the disintegrated rocks to the mouth of the stream into the Trinity, forming the flats and bars, yielding the miner a rich reward. The mountain ranges and ridges in which the waters of Stuart's Fork, Cañon, and other streams head present a promising field for the prospector.

DEADWOOD DISTRICT.

(Plates IV and V.) T. 33 N., R. 8 W., M. D. M. This district is situated in the Trinity Range of mountains on the western slope, the mineral belt being a continuation of the French Gulch on the eastern slope. During the past year there have been but few discoveries made. The Bartred Company are prospecting the lower levels of their property.

My examinations were principally of the property of the Brown Bear Company. In the report of the State Mineralogist of 1888, a complete description is given of the company's mill and workings. The mill has been running without interruption from that date. Sketch as

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rock, much altered, which was no doubt originally of the augite series, the augite having changed to a talcose mica (sample in Bureau). Following across the dividing ridge, the formation as indicated by the high peaks is composed of porphyritic dolerite, very compact; in some of the peaks standing in prismatic columns of the basalts.

The quartz bowlders found on the surface at Tamarack, upon being broken, display the gold associated mainly with iron oxides, the richer portion being principally in the seams and weathered openings. These gold-bearing bowlders cover a strip down the mountain side, about four hundred feet in width; bowlders found above this belt or strip are mainly white quartz occasionally showing streaks of gold. From thorough examinations, I am of the opinion that the main float has been carried from the vein of the Castle Rock Claim, and that by prospecting the ledge, the company will discover the pay shoot. The company are erecting arrastras. During the winter months the snowfall in this district is from four to twelve feet.

NEW RIVER MINING DISTRICT,

T. 37 N., R. 12 W., M. D. M. Located on Slide Creek, heading in the Salmon Mountains.

The Mountain Boomer Mine.—Three-stamp mill; weight of stamps, four hundred and fifty pounds; water power from Slide Creek. The work here is upon a mountain slide composed of quartz, with sands and clay of a reddish cast, no doubt from iron; the width of the slide is three hundred and seventy feet, and it is covered with soil; the various matters are approached and worked through tunnels; there are fifteen miners employed here and two mill men; there are about four tons of ore crushed daily, and its average value is $30 per ton.

The Irwin Mine.—Located west of the Mountain Boomer Mine. There is a two-foot vein and the ore averages $30 per ton. This ore is worked by the Mountain Boomer Mill.

Tough Nut Claim.—This claim is situated about a mile and a half below the Mountain Boomer; no vein; this is a mountain slide of auriferous clay; it is worked by tunnels and drifts; the ore averages $40 per ton, and is worked in the Mountain Boomer Mill.

Excelsior Mill and Mining Company.—Located on Slide Creek. Six-stamp mill; two mortars in sections, three stamps to each mortar; quartz vein broken and irregular; nothing doing.

The Ridgeway Mine.—This mine belongs to an English company; ten-stamp mill; stamps, seven hundred and fifty pounds each; two mortars, two steam engines, two boilers. The company also run a sawmill. There is a shaft on the mine one hundred and fifty feet deep. At present they are running a tunnel to tap the vein; distance, eight hundred and forty feet.

The Uncle Sam Claim.—Situated one mile above White Rock City; three-stamp mill, steam power; ledge, twenty inches; average grade of ore, $35; tunnel, one hundred and fifty feet, with sixty feet back on vein.

Developments are under way on the Hunter, Mary Blaine, Excelsior, and other locations. The Sherwood Mine is under lease; the mill running on the ore and that from the Hely Mine.

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38. Chapman & Fisher, Trinity (bench), T. 33 N., R. 11 W., Secs. 19, 29, and 30..640.00 acres.
39. Sheridan Placer, Trinity (bench), T. 33 N., R. 11 W., Sec. 19..........104.25 acres.
40. Hunt & Ellison, Trinity (bench), T. 33 N., R. 11 W., Sec. 35..........100.00 acres.
41. I. Sturtevant, Trinity (bench), T. 33 N., R. 11 W., Secs. 18 and 13.......... 74.20 acres.
42. Mt. Morensis, Trinity (bench), T. 38 N., R. 11 W., Secs. 9, 15, and 16......356.07 acres.
43. Red Hill, Trinity (bench), T. 33 N., R. 11 W., Sec. 35..........123.10 acres.
44. Hanson, Trinity (bench), T. 33 N., R. 11 W., Secs. 27, 36, 37, and 35...... 30.72 acres.
45. McGilloray, Trinity (bench), T. 33 N., R. 11 W., Secs. 27, 36, 34, and 35...582.87 acres.
46. Stoddard, Trinity (bench), T. 33 N., R. 11 W., Sec. 34.......... 51.49 acres.
47. Sigalia, Trinity (bench), T. 33 N., R. 11 W.......... 55.28 acres.
48. Hubbard & Trelon, Trinity (bench), T. 33 N., R. 11 W., Sec. 32.......... 20.00 acres.
49. Whitman.......... 21.00 acres.
50. Old Hydraulic, T. 33 N., R. 11 W., Sec. 28.......... 36.00 acres.
51. Smith & Watrous, East Fork bank.......... 20.00 acres.
52. Good Friday, Arkansaw Dam, T. 33 N., R. 10 W., Sec. 20.......... 21.00 acres.
53. Hubbard Mine, T. 33 N., R. 10 W., Sec. 2.......... 40.00 acres.
54. H. Jacobs (drift), T. 33 N., R. 11 W., Secs. 34 and 35.......... 71.35 acres.
55. Bartlett & Jacobs (drift), T. 33 N., R. 11 W., Secs. 35 and 2..........136.18 acres.
56. Patterson Placer (drift), T. 33 N., R. 11 W., Secs. 2 and 35.......... 39.73 acres.
57. A. H. Hayes, McKinney Bench, T. 33 N., R. 11 W., Secs. 12 and 13..........113.44 acres.
58. A. H. Hayes, Picket Bench, T. 33 N., R. 11 W., Secs. 12 and 13.......... 45.95 acres.
59. A. H. Hayes, Keno Bench, T. 33 N., R. 11 W., Secs. 12 and 13..........123.62 acres.
60. A. H. Hayes, Baker's Bar (bench), T. 33 N., R. 11 W., Secs. 12 and 13.... 32.24 acres.
61. A. H. Hayes, Boston No. 5 (bench), T. 33 N., R. 11 W., Secs. 13 and 14....133.68 acres.
62. Gribble Placer, Trinity (bench), T. 33 N., R. 11 W., Secs. 19 and 30...... 30.82 acres.
63. Robb & Perkins, Trinity (bar), T. 33 N., R. 11 W., Sec. 35..........241.34 acres.
64. Land & Junkins, Trinity (bench), T. 33 N., R. 11 W., Secs. 5, 32, and 33..........
65. Carr & Co., Trinity (bench), T. 33 N., R. 11 W., Sec. 33.......... 65.00 acres.
66. Jones & Post, Trinity (bench), T. 33 N., R. 11 W., Sec. 20.......... 40.00 acres.
67. Curry Placer, Trinity (bench), T. 33 N., R. 12 W., Secs. 5 and 6..........106.14 acres.
68. Tom Price, Trinity (bench), T. 33 N., R. 12 W., Sec. 5.......... 27.11 acres.
69. Skunk Point, Trinity (bench), T. 33 N., R. 12 W., Sec. 4.......... 14.00 acres.
70. Hubbard Mine, Trinity (bench), T. 33 N., R. 10 W., Sec. 2.......... 40.00 acres.
71. Martinville Placer, T. 6 N., R. 6 E..........158.30 acres.
72. Hawkin's Bar Placer, T. 6 N., R. 6 E..........119.95 acres.
73. Hawkin's Bar Hydraulic, T. 6 N., R. 6 E.......... 59.84 acres.
74. New River Hydraulic Mining Company, T. 6 N., R. 6 E..........

Something over seven thousand five hundred acres, the greater part being patented. The Dutton's Bar, old channel end, contains several hundred acres, and the old channel from Swift Creek, through the Buckeye Mountains, contains many thousand acres not included in the above. The Buckeye channel extends through Townships 36, 35, and 34, Ranges 7, 8, and 9 W. This great tract of mining ground all contains gold—the greater portion of which will yield handsome returns by hydraulics, as evidenced in the northern end at Trinity Center, as well as at points worked along the line, and at the southwestern end at Oregon Gulch.

The State Mineralogist, in his report of 1889, referring to the hydraulic mines of the northern counties, says:

"In that region there exists no objection to its (hydraulic mining) being prosecuted, while the conditions are exceptionally good. Owing to scarcity of water, this class of miners harvested but a scanty gold crop last year. Their compensation came, however, later on. The early advent and great abundance of the fall rains enabled them to begin piping more than a month earlier than usual, while the heavy stock of snow on the mountains insured them an ample water supply far into the dry season."

Most of the miners inaugurated work in a small way, depending mainly on the small streams heading in the mountains in the immediate vicinity of their claims, giving but short runs, the average not exceeding four hours daily during a season of five months during the wet season, being compelled to store the waters twenty hours of each day to secure water the four hours, making a run of five hundred hours during the year, using one pipe. These claims yield during the season from $3,000 to $29,000. I have visited one claim, the Haas, that produced

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between one thousand five hundred and one thousand six hundred ounces of gold during a season of six months, working two pipes (giants), with a total hours run of about one thousand three hundred.

Upon running the eye over the map of Trinity, it will be observed that the county is completely surrounded by high mountain ranges and abrupt "sierras." The channel of the Trinity is in the deep cañons between the ranges. The main confluents of the streams heading in the northwest—Coffee, Swift, Rush, Stuart's, and Cañon Creeks, as well as those from the eastern range, the East Fork, Grass Valley, and Brown Creeks—carry great volumes of water throughout the year, and, with the exception of Cañon Creek, have not been tapped at any great elevation. The mines at Trinity Center are well supplied with water throughout the season, although their piping capacity will be greatly increased by connecting the ditches with the lakes in the high ranges. The Hayes property has a yearly supply from Cañon Creek, headwaters, and lakes. These claims yield from $50,000 to $100,000 yearly.

The waters of Stuart's Fork afford abundant supply to work down the great auriferous deposits of the Buckeye channel; the same stream, Rush or Cañon Creeks, for Oregon Mountain, the Ward and Dutton Bar properties; or, by looking to the waters of Grass Valley and Brown Creeks, ditches would carry the waters to the last mentioned properties. Cañon Creek and feeders are ample for the great and rich benches of Red Hill and adjoining properties. Truly, the wealth of Trinity is in its gravel. Nature has certainly been bountiful with its waterways, heading in the high ranges in the region of the great banks of snow, the rich deposits of gravels, and the natural channel drain.

As stated by United States Deputy Surveyor William Lowden, who has resided in this section of Trinity from 1850, having surveyed the ditches, trails, roads, and boundaries, and consequently familiar with the topography of the whole county: "There is no mining land in this county situate so that the working of the mines will damage any agricultural land."

What little farming is done is generally above the bed of the river on small benches, the product finding market to the miner.

There is no objection to hydraulicking—no farms to injure; it being a mountainous country, with deep ravines and high ranges, and thousands of acres of gravel, averaging thousands of dollars in gold per acre. With capital to collect the waters at their sources to reach the high deposits below, the yield of Trinity County will be greatly increased.

SAMPLES OF GOLD FROM HYDRAULIC MINES FORWARDED TO BUREAU.

1.	Haskins, Hatchet Creek, T. 36, 37 N., R. 7 W.	100 grains.
2.	Coyle Mine Claim, T. 36 N., R. 7 W.	120 grains.
3.	Center Mine Claim, T. 36 N., R. 7 W.	480 grains.
4.	McMurry & Hupp Claim, T. 33 N., R. 9 W.	120 grains.
5.	Hurst & Ellison Claim, T. 33 N., R. 10 W.	60 grains.
6.	Fred. Haas' Claim, T. 33 N., R. 10 W.	120 grains.
7.	David Evans' Claim, T. 33 N., R. 11 W.	65 grains.
8.	A. H. Hayes' Claim, T. 33 N., R. 11 W.	120 grains.
9.	Smith & Watrous' Claim, T. 35 N., R. 11 W.	122 grains.
10.	Ward Mine Claim, T. 33 N., R. 10 W.	120 grains.
11.	Chapman & Fisher Claim, T. 33 N., R. 10 W.	224 grains.
12.	Mammoth Claim, T. 34 N., R. 11 W.	120 grains.
	Total	1,771 grains.

SAMPLES OF PLATINUM.

F. Meckel, North Fork, T. 34 N., R. 11 W.	410 grains.
Geo. Chapman, T. 33 N., R. 10 W.	484$\frac{4}{10}$ grains.

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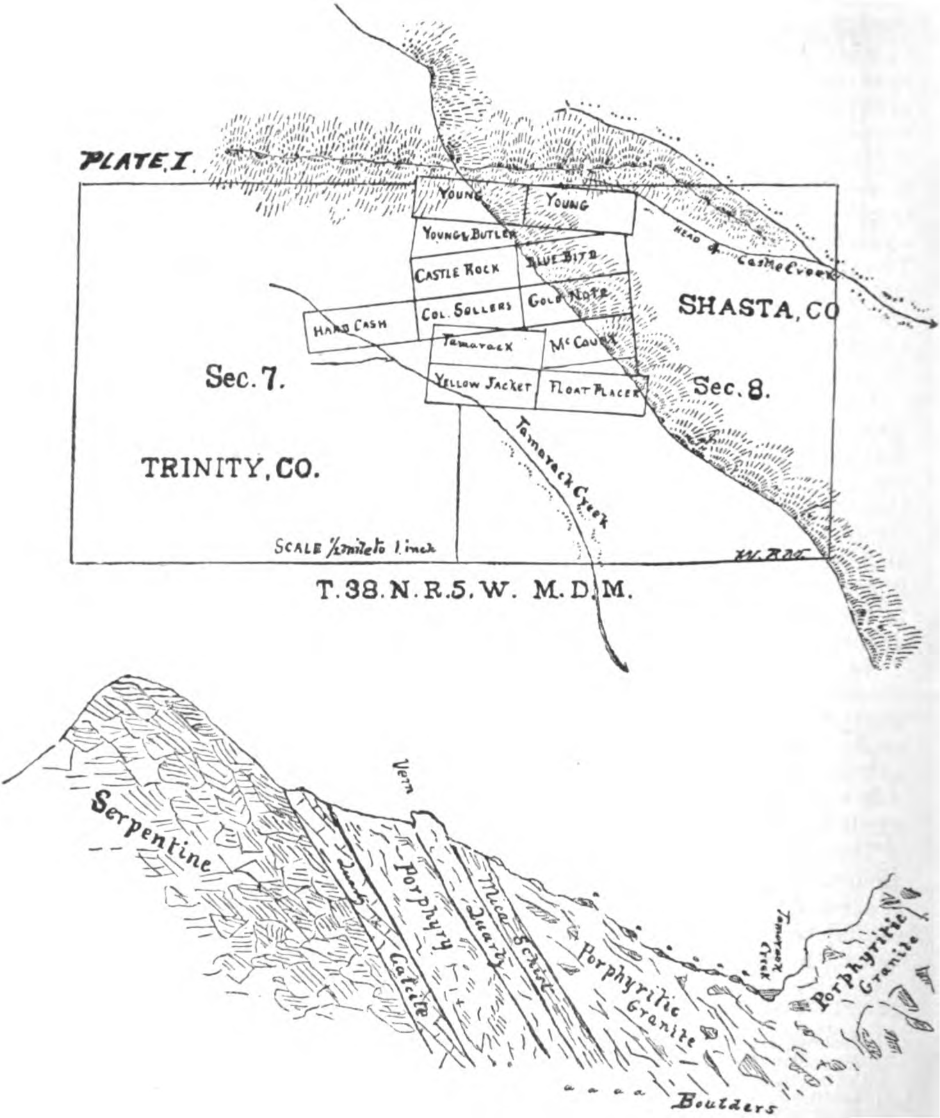
PLATE I.



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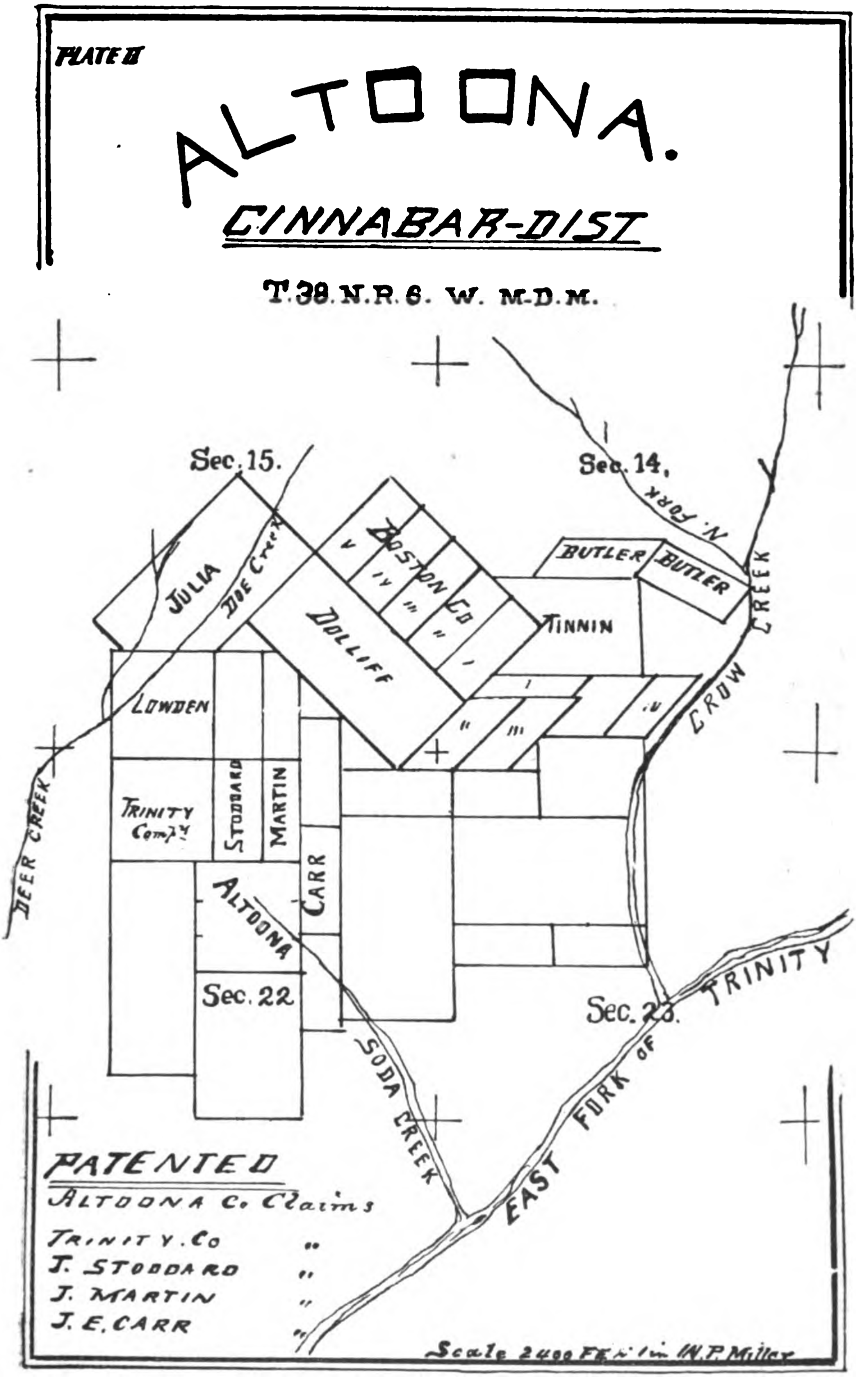
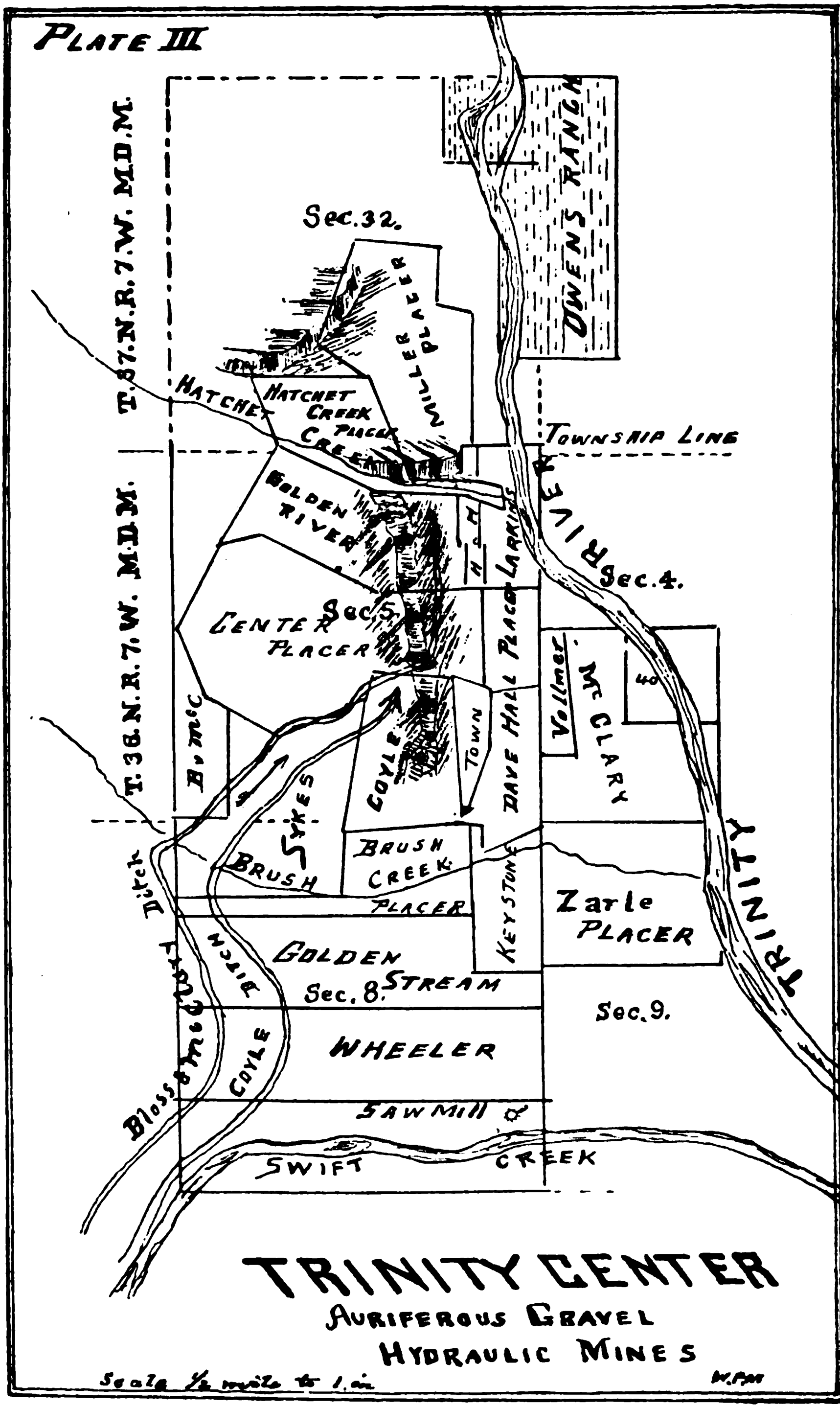


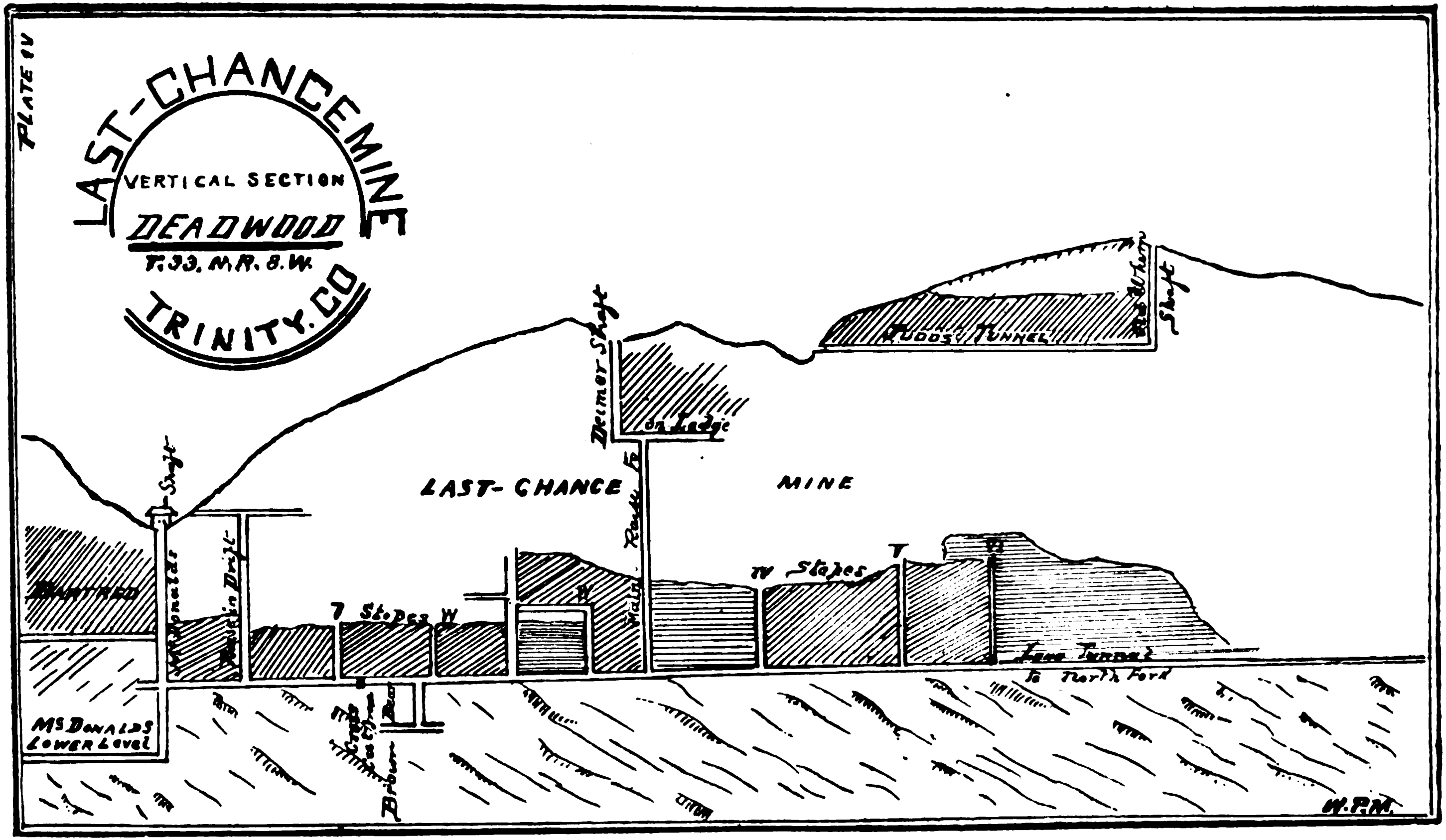
PLATE II
ALTOONA.
CINNABAR-DIST
T. 38. N. R. 6. W. M.D.M.
Sec. 15.
Sec. 14.
Sec. 22
Sec. 23.
JULIA
DOE CREEK
BOSTON CO
DOLLIFF
BUTLER
BUTLER
TINNIN
N. FORK
CROW CREEK
LOWDEN
TRINITY Compy
STODDARD
MARTIN
CARR
ALTOONA
DEER CREEK
SODA CREEK
EAST FORK OF TRINITY
PATENTED
Altoona Co. Claims
Trinity. Co "
J. Stoddard "
J. Martin "
J. E. Carr "
Scale 2400 Feet 1 in W. P. Miller

PLATE III



TRINITY CENTER
AURIFEROUS GRAVEL
HYDRAULIC MINES

Scale 1/2 mile to 1 in



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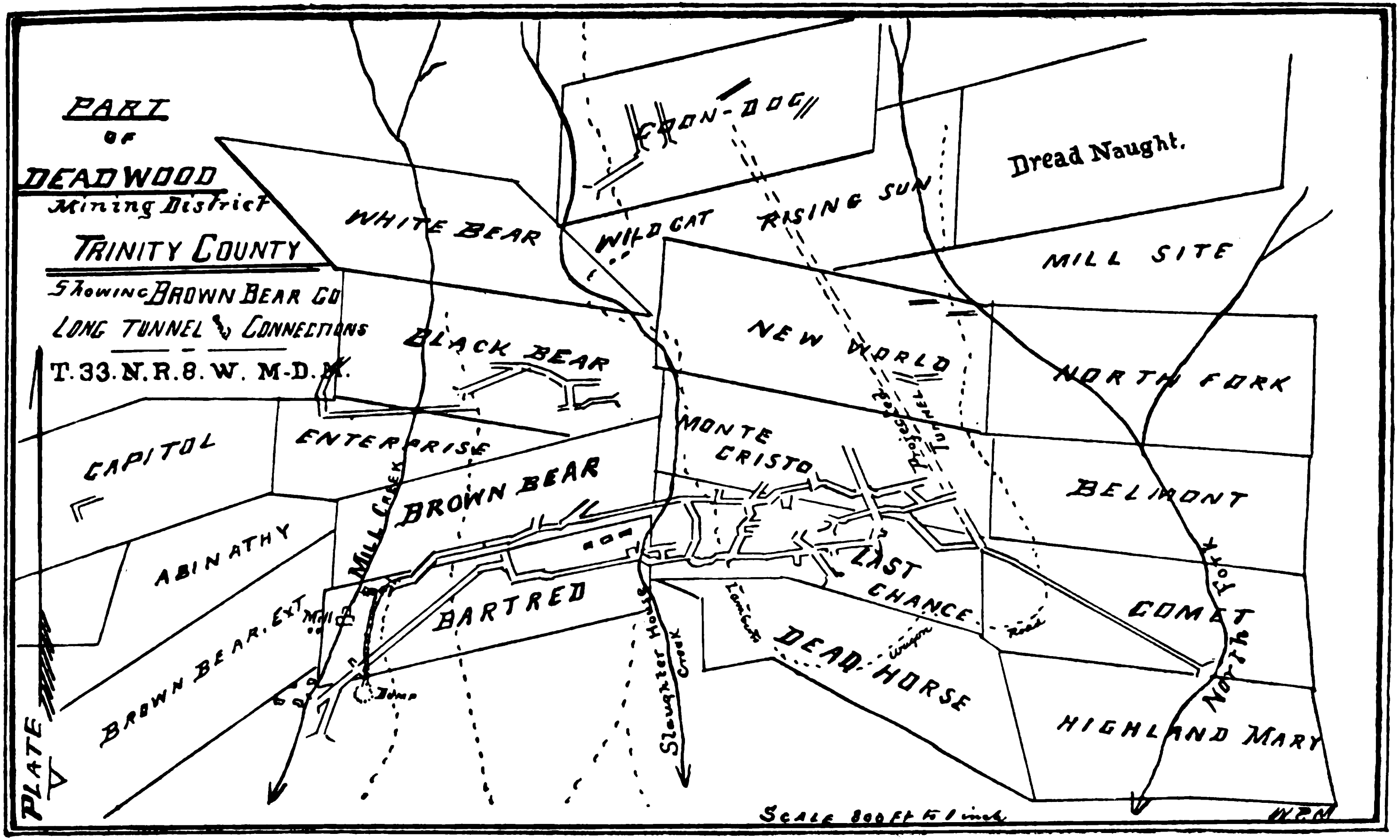

PART
OF
DEADWOOD
Mining District
TRINITY COUNTY
Showing BROWN BEAR CO
LONG TUNNEL & CONNECTIONS
T.33.N.R.8.W. M-D.M.
PLATE V
WHITE BEAR
WILD CAT
RISING SUN
Dread Naught.
MILL SITE
BLACK BEAR
NEW WORLD
NORTH FORK
CAPITOL
ENTERPRISE
MONTE CRISTO
Projected Tunnel
BROWN BEAR
BELMONT
ABINATHY
Mill Creek
LAST CHANCE
COMET
BROWN BEAR. EXT
BARTRED
Slaughter House Creek
DEAD HORSE
Wagon Road
HIGHLAND MARY
North Fork
Dump
Scale 800 ft to 1 inch
W.R.M.

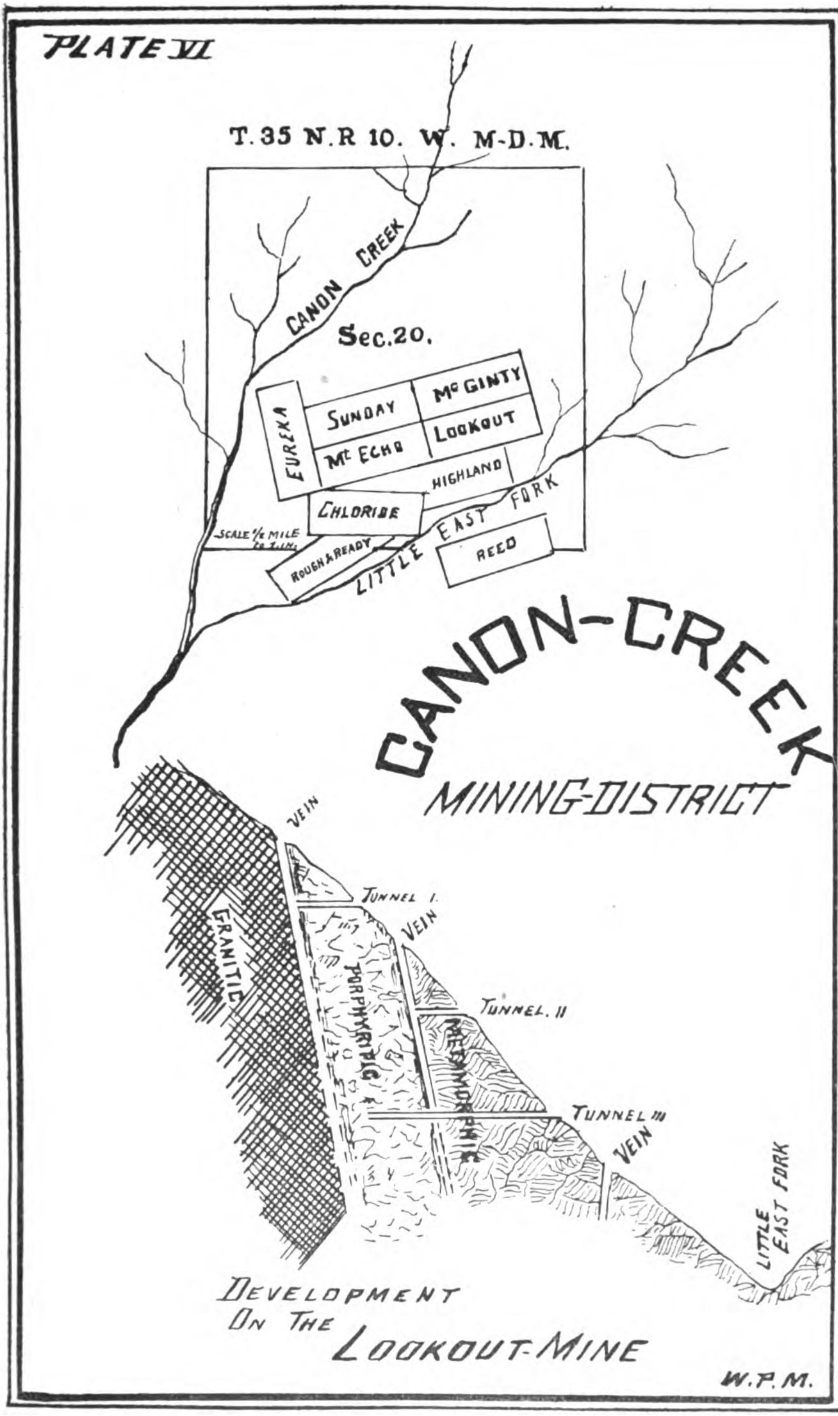
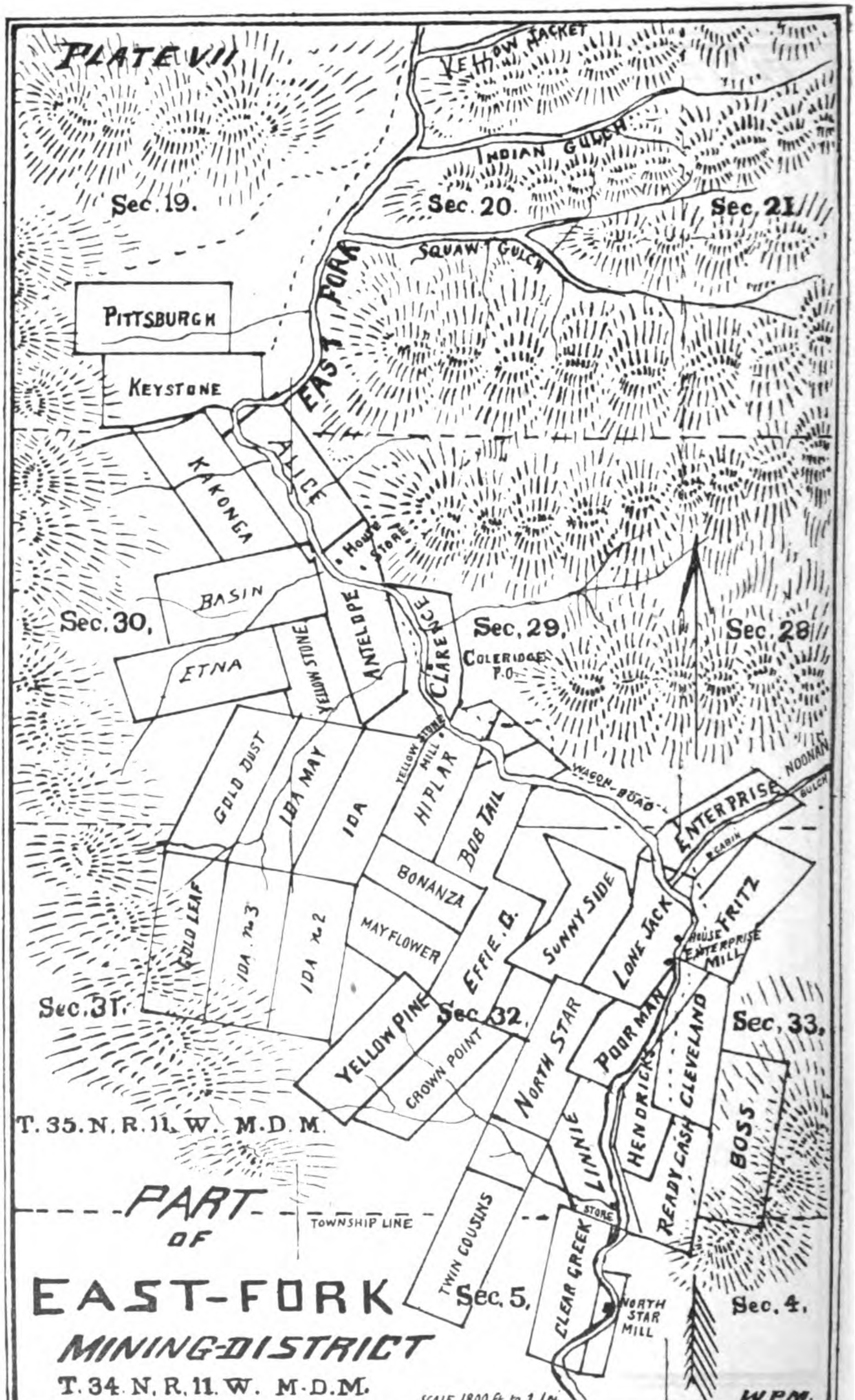


PLATE VI
T. 35 N. R 10. W. M-D-M.
CANON CREEK
Sec. 20.
EUREKA
SUNDAY
McGINTY
LOOKOUT
Mt ECHO
HIGHLAND
CHLORIDE
SCALE 1/2 MILE TO 1 IN.
ROUGH & READY
LITTLE EAST FORK
REED
CANON-CREEK
MINING-DISTRICT
VEIN
TUNNEL I.
VEIN
GRANITIC
PORPHYRITIC
TUNNEL II
METAMORPHIC
TUNNEL III
VEIN
LITTLE EAST FORK
DEVELOPMENT ON THE LOOKOUT-MINE
W.P.M.



PART OF EAST-FORK MINING-DISTRICT

T. 34. N. R. 11. W. M.D.M.

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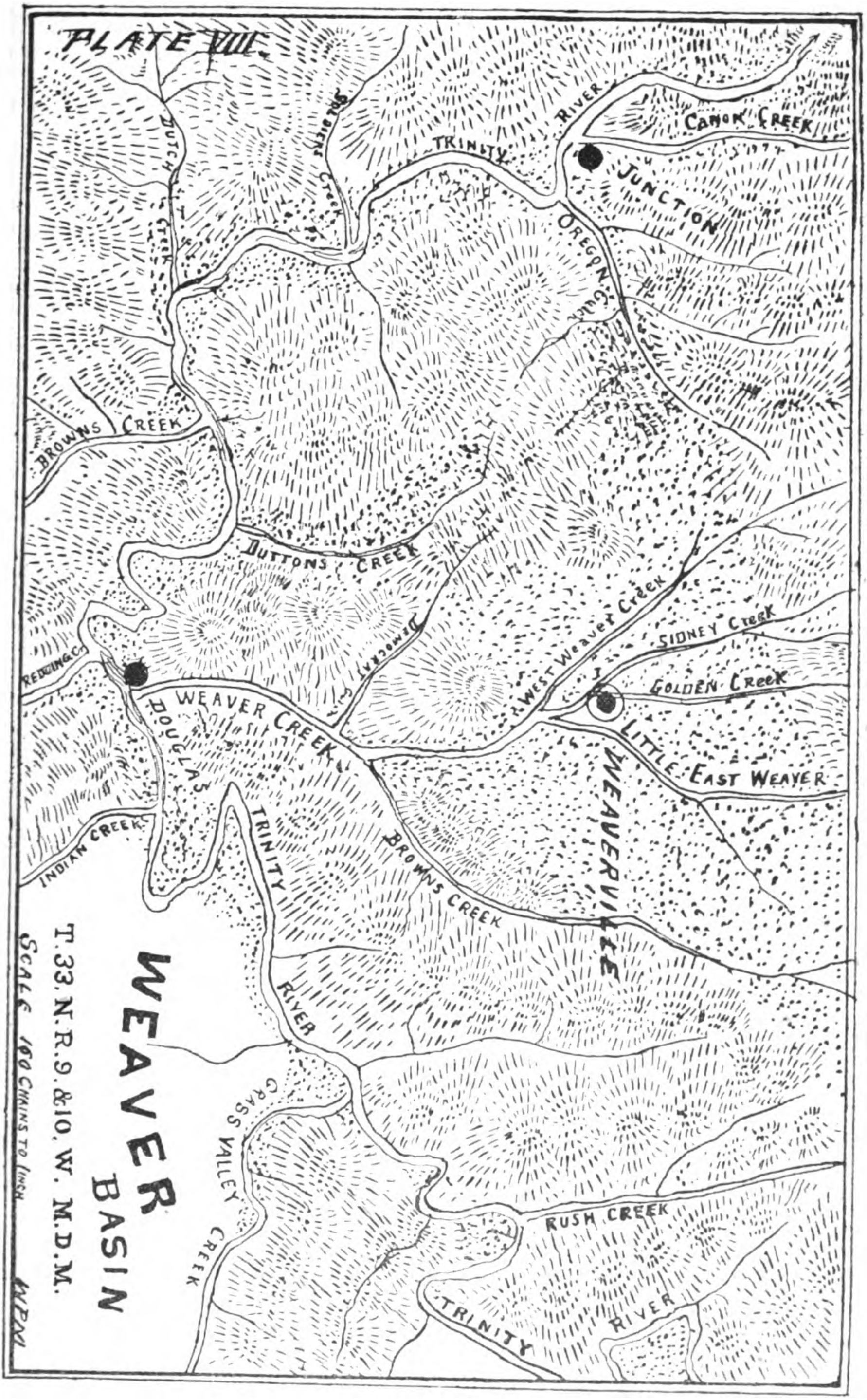

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three thousand four hundred and twenty-five acres, giving one million nine hundred thousand bushels; in corn, one thousand five hundred and twenty acres; five thousand five hundred and eighty-five acres in vineyard, and three hundred and eighty-seven thousand two hundred and fifteen acres in fruit trees.

LUCERNE.

A portion of the famous Lucerne country, formerly called Mussel Slough, in this county, north of the Tulare Lake and receiving the waters of King's River, is distinguished for its productiveness. Wheat and stock have been the chief products, but now the raisin grape is attracting much attention. The raisins of this section are surpassed by few, if any, in the world. Irrigation is conducted by canals from mountain streams and artesian wells. There are between two hundred and fifty and three hundred miles of irrigation canals, and over $1,000,000 invested in them. There are also more than two hundred artesian wells in the valley from one hundred and twenty to one thousand one hundred feet in depth. The soil is gravel and clay; occasionally a tree has been struck in boring, but no rock was ever reached.

MINERALS.

Mr. S. Barton, an observing gentleman, and a writer upon the mineralogy and geology of the Sierra Nevada, says: "Of the streams that drain the western slope of the mountain in Tulare County, only two of any size have failed to yield placer gold; these streams are the Kaweah and the Tule Rivers. North of the White River there is scarcely any evidence of early prospecting to be met with." But on the headwaters of the Middle Fork of the Kaweah is Mineral King District (sixty miles northeast of Visalia by road), the discovery of which created a great excitement nearly twenty years ago. There was no placer gold reported, but there were many mineral-bearing veins claimed to be rich in gold, silver, lead, and zinc in veins of limestone. About 1875–76 efforts were made to work these mines, but soon abandoned. The mines of this district were fully described in the report of the State Mineralogist for 1888.

This section of the Sierra west of the great cañon of Kern River, trending southwest and sinking to the plain east of Bakersfield, bears the distinctive name of Greenhorn Mountain. The rivers cut its stratification at right angles, showing granite, limestone, marble, slate, hornblende, and other rocks. Granite predominates, but limestone and marble are shown in immense bodies. At Mineral King fossils are in calcareous slate. On Rattlesnake Peak, in T. 15 S., R. 25 E., M. D. M., is a slate formation in which is imbedded great quantities of pebbles of mica slate, hornblende slate, quartz, and granite; and when this rock is decomposed, placer gold is found in the gulches, showing it to be among the oldest of the gravel deposits.

High in the Sierra near Mount Bruner, possibly in Inyo County, are a number of veins owned by Messrs. Dallidel and Soto, which produce very rich specimens of ore, bearing gold, silver, and copper. These have been partly opened and some excellent ore taken out, but the inaccessibility of the region has prevented their development.

On White River, Mr. D. W. Grover, of Santa Cruz, owns the Mammoth

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Electrum, a white variety of gold, containing two parts of quicksilver to one of gold, found on White River, Tulare County.

Specular Iron, found in Drum Valley near the Fresno County line; also, in the eastern part of the county on unsurveyed land. The mines are not worked.

Manganese is found in extensive deposits on Upper Tule River.

Antimony is found in Mineral King District, also on Tule River.

Silver and *Lead* are found in Mineral King District.

Copper is found on Tule River, also in Drum Valley near Mount Bruner, and on a branch of King's River in Tulare County.

Gypsum is found in large quantities at the foot of the Mount Diablo Range in the southeastern part of the county.

Coal is found in the Mount Diablo Range.

Asbestos, but not of the best quality, is obtained in Frazier Valley in T. 20 S., R. 29 E., on Tule River, twenty-five miles east by south of Tulare City.

Serpentine of a fair variety, also pyrallolite, are also found in Frazier Valley.

Pyrope Garnets of a good quality are found on Rattlesnake Creek and in Drum Valley; good for cutting.

Rose Quartz of a fine quality and suitable for making into ornaments is found on the Yokohol, a creek which heads between the heads of Kaweah and Tule Rivers, and flows northwest to the Kaweah.

Onyx of a fair variety has been found on Merthen's Ranch on the Yokohol.

Feldspar, a pure white variety, is abundant in Sec. 30, T. 20 S., R. 29 E.

Black Tourmaline of a fine quality is found in Stokes Mountain, Drum Valley, and near Three Rivers.

Epidote and *Garnets* of different varieties are found at Barton Point, Three Rivers, Mineral King, Drum Valley, and Tule River.

Topazolite, a rare variety of garnet, is found in the northwestern part of the county.

Stalactites and *Stalagmites* are found in great abundance and beauty in Clough's and Palmer's Caves. Clough's Cave is on the north bank of the South Fork of the Kaweah River, fifteen miles above Three Rivers Post Office. The character of the formation of the Three Rivers country, according to the opinion of scientific men, indicates that precious stones will be found there.

Magnetic Sand is in abundance on the North Fork of the Kaweah River, and at Barton's Point, but does not contain gold.

Fossils, of the Lower Silurian formation, are abundant on the western shore of Tulare Lake, also many Indian relics. Indian arrowheads of obsidian and flint are found in their burial places in various parts of the county.

FORESTS.

The forests of Tulare are fitting crowns to its mountain scenery. Such are the "Big Trees," or the *Sequoia gigantea*, of Tulare's mountains. They usually measure from twenty-five to thirty feet in diameter at ten feet above the base; some measure thirty-five feet, and one giant is reported as measuring forty-six feet in diameter, and reaching to the height of four hundred feet. This is the largest tree of the known world. The thousands of years of its growth can only be surmised.

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Smaller ones have been felled whose annular lines of growth indicate three thousand years of life. This American tree has fitly been given the name of the American Cadmus Sequoia. There are estimated to be thirty thousand of this species of trees in Tulare County, in groves and scattered. The "Big Trees" of Calaveras and Mariposa have long been known, but the larger ones and greater number existing in Tulare are comparatively unknown to the world. The mountain area of Tulare County comprises more than three thousand square miles.

There are trees of many varieties in the forests of Tulare: Sugar, yellow, and other pines, redwood, white, live, and black oaks, tamarack, laurel, birch, maple, madrone, fir, manzanita, mountain mahogany, and others, of value for timber, ornamental wood, implements, machinery, and fuel.

A species of black oak is abundant in the high mountains, which is well adapted to the manufacture of all classes of machines, tools, wagons, and agricultural implements.

For the details of the forests of Tulare the writer is indebted to F. J. Walker, Esq., of Visalia, who has made very extensive explorations of the mountains, the special localities of great forests, there being big trees in many areas, as follows:

Redwood Cañon, on the north line of the county, a stream flowing due south and emptying into the Kaweah, has three thousand acres of trees, and one thousand trees to each quarter section; some are sequoia, and twenty-five feet in diameter.

The North Kaweah Groves are held by the Government on the allegation that the settlement was not in good faith, but in the interest of foreign speculators. The colony, however, has maintained its location, constructed a most excellent road to their mountain home, published and maintained a newspaper in their settlement called the "Kaweah Commonwealth," and given other evidences of good faith.

Kaweah Tule Grove is on the divide between South Fork of the Kaweah and North Fork of Tule Rivers, and covers between four thousand and five thousand acres. Part of this is known as the Dillon Mill Tract. While this is a "Big Tree" grove, it has a large number of sugar pines, which are big trees themselves, about as large as can be handled.

Mineral King Groves include Salt Creek, Oriole Lake, Atwell's Mills, and Redwood Meadows.

Middle Tule Grove comprises several groves in an extensive region. Sec. 16, T. 19 S., R. 31 E., is covered with sequoia and bears the distinctive designation of the Big Tree Grove.

South Tule Grove includes the Coburn Mill country, Frazier Mills, Pixley Tract, School Section, Putnam's Mills, and Kissing Tract. On the east branch of Middle Tule are two groves of trees of considerable importance. This belt is usually about six thousand feet of elevation. Eastward is the belt of the Kern River country.

Freeman's Valley Grove is probably the finest in the State of sequoia and general forest trees. It lies opposite the head of Tule River, and it is estimated to have one million five hundred thousand feet of lumber per acre. There are eight hundred acres of redwood in the grove.

Parkins' Meadow Grove is a system of little valleys, seven to nine miles in extent.

Mammoth Grove is on Deer Creek, six miles north of the boundary line of Kern County. There are one hundred and thirty "Big Trees" in this grove, which is the most southerly in the State.

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TUOLUMNE COUNTY.

By L. P. Goldstone, E.M., Assistant in the Field.

Tuolumne County is one of the principal mining counties of the State, and covers an area of about two thousand square miles. Its eastern boundaries are the summits of the Sierra Nevada Mountains, from whence the decrease in altitude through the foothills of that range to the western boundary line is quite regular and gradual. The general topography of the county is necessarily quite rough and rugged, containing, as it does, between its eastern and western boundary lines little besides hills and mountains. The county is generally well watered by the Tuolumne and Stanislaus Rivers and their numerous tributaries, the latter stream forming a part of the northern and western boundary of the county. From an altitude of three thousand feet, extending eastward toward the Sierra Nevadas, is an immense acreage of commercial timber, while in nearly all localities a sufficiency of timber for mining purposes is found. The climate is unexcelled, and all kinds of fruits are grown of an exceptionally fine quality. Cereals of all kinds are raised, and in fact almost anything that will thrive in any locality thrives here; even tobacco, small quantities of which are raised in several places on the forks of the Stanislaus River, of excellent flavor.

The geological character is varied. In many places it is volcanic, the main feature of which is the extensive basaltic table land running for many miles through the county near to and bordering on the Stanislaus River. The eastern portion of the county is granitic in character, with occasional dikes of porphyry and here and there cappings of basalt. The granite in many places gives evidence of its once plastic condition. The western portion of the county is made up of slate rocks, argillaceous, siliceous, and talcose in character. Belts of serpentine cross north and south through the western slate formations, and for a long distance one of them runs parallel with and near to the west wall of the great gold-bearing lode—the Mother Lode of California—which courses north about 35 degrees west through this county.

THE VOLCANIC TABLE.

The volcanic table mountain of the county is one of the most peculiar geological features of the State. It is in the neighborhood of thirty miles in length, having a general northeasterly course. The capping is basalt, columnar in structure, which overlies a volcanic ash, which itself overlies a deposit of auriferous gravel. That this volcanic matter overlies the channel of a once swift stream, all conditions and evidences tend to prove. Numerous tunnels have been drifted into the mountain, of lengths varied by the conditions of the surface ground; some at points where slate forms the bed of the table, and others at points where limestone is the underlying rock. These changes are due to the fact that the table crosses the formations in a general northeast-

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deeper, had not water prevented further exploration; and that this chemical action is due more especially to the detritus and debris washed from the surrounding country, where the slates and country rocks are of varied character and highly mineralized. These have undoubtedly formed reactions with the limestone, and by the agency of flowing water, of which undoubted signs are extant, and by these means Nature has carved these monuments to herself. The crevices and miniature caverns, through time, as they were formed, finally filled with this matter above referred to, which had carried with it gold, broken and disintegrated from the ledges of the surrounding country, and so were formed the richest placers ever discovered, which brought to "Old Tuolumne" its first extensive influx of population, many of whom are still among its most prosperous citizens.

There are several quarries of good marble and granite of superior texture and color in the county. Soapstone, or steatite, suitable for furnace lining, is also found in several localities; but beyond the local consumption, very little of the latter is used, their situation being so remote from rail.

POCKET MINES.

This county, in the immediate vicinity of Sonora—that is to say, within a radius of several miles—is noted for the great number of "pockets" of gold that have been taken out. Bald Mountain, and in the vicinity of the Bonanza Mine, have produced a greater number of pockets, varying in value from a few hundred dollars to many thousands, than any other mining section in the world. "Jackass Hill," about four miles northwest in an air line from Sonora, is also a noted pocket district. The chief of all the noted veins of this character is undoubtedly the Bonanza. In the neighborhood of $2,000,000 have been taken from this mine, and the judgment of experienced miners in this branch of mining is, I am informed, that all "signs" indicate further successes in it in the near future. The mine has been so well described in former reports that I will simply give an outline of the work to date. The fissure is twelve feet in width, and contains three veins of quartz; the foot wall vein is about four inches in width, the hanging wall vein about the same width, and the middle vein averages thirteen inches. The hanging wall vein is separated from the middle vein by about eight feet of siliceous limestone, while the foot wall vein is separated from it by two and one half feet of the same matter. The veins are parallel to one another, and dip to the west 30 degrees from the horizon, and the course of the vein is north 30 degrees east. The incline from the old works was run on the vein with an average pitch of 21 degrees, and has been stoped for five hundred and eighty feet in length. The tunnel was driven in from the surface five hundred feet, cutting the vein at about two hundred and ninety feet on the incline. The new shaft has been sunk at a pitch of about 20 degrees one hundred and eighty feet in depth, which will strike a line through the incline one hundred and fifty-six feet from where the stopes terminate. This gives a vertical depth of two hundred and sixty feet from the top of the old incline shaft. It is the opinion of all in this branch of mining that in stoping this one hundred and fifty-six feet large returns will reward the lessees, which they undoubtedly deserve. During the period of fifteen months ending July, 1890, this property has produced in bullion $198,764.

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Boston, New York, and Humbug. The method of working the gravel in all of these mines is similar to that adopted in the Empire. I will let this description of it suffice for all.

QUARTZ MINES.

THE GOLDEN GATE MINE.

This property is situated in Sec. 1, T. 1 N., R. 14 E., M. D. M., and in Sec. 36, T. 2 N., R. 14 E., M. D. M., about one and one half miles south of Sonora, at an elevation of about one thousand nine hundred feet above sea level. The dimensions of the claim are two thousand nine hundred feet in length by six hundred feet in width. Milton, Calaveras County, the terminus of the Milton and Copperopolis Branch Railroad, is the point from where supplies are hauled, freight costing from there 50 cents per one hundred pounds.

The course of the vein is northeast and southwest, dipping to the east at an angle of 70 degrees, and averaging in width six feet. The walls are of slate, through which the vein cuts, making an angle with the stratification of 70 degrees. The mine is opened by a shaft and tunnel, the tunnel being run northeast four hundred feet on the vein. Near its mouth the main shaft has been sunk to a depth of three hundred feet. The face of the tunnel is two hundred and twenty-five feet below the surface. It is timbered one hundred and fifty feet of its length by round pine timber, costing 7 cents per foot. Two feet per shift was the length run in it. The shaft is four and one half feet by six feet in the clear, its bottom being vertically two hundred and twenty-five feet below the surface, and costing $13 per foot to sink. Three levels have been run north and south on the vein from it. No. 1 is fifty feet long, running north, and is one hundred feet below the surface. Below this level, at the depth of about seventy-five feet, No. 2 drift has been run two hundred and fifty feet north, and from it, almost its entire length, stopes have been driven, averaging about sixty feet in height. One hundred feet below No. 2 the third drift or level has been run north thirty feet and south eighty feet. On the south side of the shaft at this level, some stoping has been done. From the surface tunnel, during its entirety, stopes have been raised to the surface, and at a point about two hundred and forty feet from its mouth a winze has been sunk about one hundred feet in depth, and from its bottom a drift has been driven north one hundred and twenty-five feet. From this latter drift for its entire length, stopes have been raised nearly to the floor of the surface tunnel.

The length of the ore shoot has not yet been determined, but continuous stopes have been driven as long as one hundred and fifty feet.

About twenty thousand gallons of water are raised to the surface by a skip every twenty-four hours. Both Hercules and Giant powder Nos. 1 and 2 are in use as explosives, and the average consumption per ton of ore extracted is one pound. The cost of mining per ton of ore is $2 50. Lumber is delivered at the works at a cost of $18 per thousand feet. The ore is transported from the shaft to the mill by small cars, a distance of three hundred and fifty feet, at a cost of 8 cents per ton. The character of the ore is quartz, carrying an average of 3½ per cent of sulphurets of iron and copper, which averages about $400 per ton. The percentage of its value in free gold is very small. The means of reduc-

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Head of water used for power hoist........ ....40 inches; mill, 150 inches.
Quantity of wood consumed for power (when used)...................... $2\frac{1}{4}$ cords per day.
Cost of wood..$4 50 per cord.
Cost of water..................................15 cents per inch for twenty-four hours.

THE SAN GIUSEPPE MINE.

This mine is situated within the limits of the town of Sonora, about a half mile west, in an air line, from the Court House. It was located many years ago, but I could not ascertain the exact year. The dimensions of the claim are one thousand five hundred feet in length by six hundred feet in width. The course of the vein is east 10 degrees north, and dips to the south at an angle of about 70 degrees with the horizon, and its average width is thirteen inches. The mine is opened by a shaft, which for its first forty feet is vertical, when it assumes the dip of the vein and continues at that inclination ninety feet to the bottom, making in all one hundred and thirty feet in depth. There are four levels running east and west on the vein: the first being at a distance of forty feet from the mouth of the shaft, running west one hundred feet. No. 2 level is thirty feet below No. 1, and runs west ninety-five feet and east forty feet; from this level the vein has been stoped for its entire length to the surface. Below No. 2, forty feet, is No. 3 level, which runs west one hundred and sixty feet and east ten feet; nearly all the vein has been taken out of it to No. 2 level. Fifty feet below No. 3 level is No. 4 level, which has been run one hundred and twenty-five feet west and fifty feet east. At a point fifty feet west from the shaft an upraise has been made to No. 3 level, and between it and the shaft, from No. 4 to the floor of No. 3, the vein has been entirely stoped out. The quantity of water coming into the mine is about twenty-six gallons per minute, and is raised to the surface by a four-inch jackhead pump.

Hercules powder Nos. 1 and 2 are used in the mine, and the average consumption is about four pounds of powder to each ton of ore extracted. The cost of mining per ton of ore is $12. The shaft is four feet by eight feet in the clear, and is timbered with sawed pine. It costs $21 per foot to sink. About one foot is sunk each twenty-four hours by three eight-hour shifts. Lumber is delivered at the mine for $20 per thousand feet. The character of the ore is white quartz, carrying 4 per cent of sulphurets of iron. At the time of the discovery of the vein, and to the depth of forty or fifty feet, it carried quite a percentage of its value in free gold, which finally disappeared, the sulphurets increasing in value. A roasting furnace was then added to the plant of arrastras, and the ore was well roasted before being ground and amalgamated. Since the purchase of the mine by the present owners, the reduction of the ore at the mine has been entirely discontinued. As the ore is extracted, it is hauled to the reduction works of Albert Maltman, situated about one mile east of Sonora, and is there crushed, concentrated, and its concentrations reduced by the Plattner process. Latterly, the ore again shows free gold. The sulphurets of this mine have been noted for their great richness and the purity of the gold contained in them. At present, sinking has begun in the mine, and the ledge seems to gradually increase in width, carrying a uniform percentage of sulphurets with the other portions of the mine, and equally as rich. Ten men are employed in the mine, and wages average $2 50 per day. The power for hoisting is obtained by a twenty-foot overshot wheel of two and one half feet face.

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owners. There are at present but three men employed in the mine, receiving wages of $3 per day. The forty-stamp mill which belongs to the property has been idle for several years, and the ore extracted is hauled to a mill about a mile from the mine. When in active operation twelve miners in the mine supplied the mill with sixty tons of ore, the amount crushed in twenty-four hours.

THE LITTLE GEM MINE.

This mine is about three fourths of a mile southeast of the Alabama Mine. It was located in 1855, and its works are at an elevation of one thousand five hundred feet above sea level. The mine has been extensively worked, but at present is idle, although its owner informs me that it will soon start again. The property has a ten-stamp mill, and occasionally a crushing of ore is taken out and milled. The dimensions of the mine are five hundred and sixty feet in length by six hundred feet in width.

THE CRYSTALLINE MINE.

This mine adjoins the Alabama on the south. It is owned by Whitmore & Seeber, and worked in a similar manner to the Alabama, namely, by open cut and tunnel. The mill contains five three-stamp batteries. Here also a crushing of ore is occasionally taken out and crushed, but at my visit the mine was idle.

SOULSBYVILLE MINING DISTRICT.

This district is six and one half miles due east from Sonora, and in it are some of the most prominent mines of the county. The district is granitic in character, as regards its country rock, with occasional dikes of porphyry coursing north and south. A very remarkable feature also occurs in this district, namely, of limestone having been encountered in the Soulsby Mine at a distance of nine hundred feet in depth, underlying the granite.

THE SOULSBY MINE.

This mine is situated in Sec. 31, T. 2 N., R. 16 E., M. D. M., about one mile north of the town of Soulsbyville. The claim was located in 1856. Its works are at an altitude above sea level of two thousand eight hundred and fifty feet, and with its extensions that have been acquired by the company since its location, it is three thousand eight hundred feet in length by six hundred feet in width. It is about fifty miles from rail, from where freight is hauled to the mine for from 75 cents to $1 per hundred pounds.

The course of the vein is north 10 degrees east, dipping to the east at an angle of 85 degrees, and the average width of the vein is fifteen inches. Its walls are granite, and next to the vein is occasionally encountered narrow seams of calcareous diorite. The mine has been extensively worked. Two main shafts have been sunk, one nine hundred feet in depth; and the Duncan shaft, one thousand seven hundred feet north, has been sunk to a depth of eight hundred feet. The great amount of work done in the mine cannot be better described than in the accompanying longitudinal cross-section which I here append:

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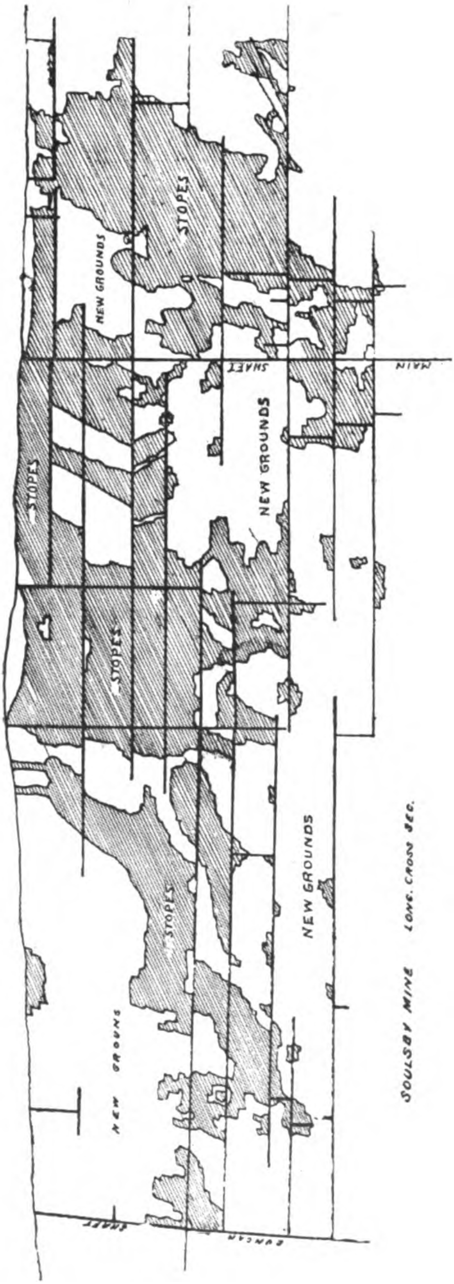
STOPES
NEW GROUNDS
MAIN
SHAFT
STOPES
NEW GROUNDS
STOPES
STOPES
NEW GROUNDS
NEW GROUNDS
SHAFT
DUNCAN
SOULSBY MINE LONG. CROSS SEC.

It shows the large amount of ore stoped, which has produced in gold nearly $3,000,000. There are seven pumps in the mine. In the Davidson shaft there are two eight-inch Cornish plungers and one eight-inch jackhead pump. In the main shaft there are two six-inch Cornish plungers and two six-inch jackhead pumps. The cost of mining per ton of ore has averaged $8.

Lumber is delivered at the mine at a cost of $15 per thousand feet. The character of the ore is quartz, highly sulphuretted with iron pyrites and galena, containing sometimes small quantities of sphalerite (zinc-blende). The mill is a fifteen-stamp mill, of seven hundred and fifty-pound stamps, which drop six inches eighty-five times per minute. Brass wire screens, fifty-mesh, are used. The size of the aprons is four feet by twelve feet, and each battery has twenty feet of sluice sixteen inches wide. The aprons and sluices are all covered with silver-plated copper. Three Challenge feeders are used in the mill. Ninety per cent of the gold recovered is saved in the battery and 10 per cent on the outside plates. The ore contains 3 per cent of sulphurets, which are valued at from $35 to $50 per ton. The average wages paid in the mine have always been $3 and in the mill $3 50. The hoist at the main shaft is supplied with power from a four and one half-foot Knight wheel, under three hundred and twenty-five feet of pressure of water, and is also supplied with a twelve by thirty-inch cylinder, horizontal engine, and a tubular boiler sixteen feet long by forty-eight inches in diameter. The hoist at the Davidson shaft has a six-foot Knight wheel to run the pumps, and at this point the pressure is three hundred and twenty-five feet. Here also is an engine of twelve by thirty-six inch cylinder, with a flue boiler twenty-four feet long by forty inches in diameter. The mill is run by a six-foot Knight wheel, under three hundred and fifty feet head of water. At present only surface work is being done, and the ore being reduced in the mill is principally from the old dumps. The illustration of the underground workings of this mine has been given, although the mine is not in active operation, to show the immense amount of work done in the mine, and its extensive ore body, and the probabilities of other ore bodies of similar magnitude being found in this vicinity.

THE BLACK OAK MINE.

This mine is in Sec. 36, T. 2 N., R. 15 E., M. D. M., about one mile southwest of the town of Soulsbyville. It was located in the year 1878, and its dimensions are one thousand five hundred feet on the vein by six hundred feet wide. The works are at an elevation of two thousand seven hundred and fifty feet above the sea level. The vein courses north 17 degrees east, and dips to the west at an angle of 70 degrees with the horizon, and averages in width three and one half feet. Its walls are granite. The mine has been opened by a shaft four hundred and thirty-nine feet in depth sunk on the vein, and from it four levels have been run north and south. The first level is one hundred feet below the top of the shaft, and runs north from it three hundred and fifty feet, and south one hundred and fifty feet. No. 2 level is sixty feet below No. 1, and runs two hundred feet to the north of the shaft. No. 3 level is one hundred feet below No. 2, and runs north also one hundred and fifty feet. No. 4 level is one hundred feet below No. 3 level, and runs north one hundred feet and south eighty feet.

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One hundred feet north from the main shaft, and extending to No. 3 level, an air shaft has been sunk, and all the ground between the two shafts, from No. 4 level to the surface, has been extracted. Also, in No. 1 level, south of the shaft, stopes have been driven about one hundred feet from the shaft and continued to the surface. Between Nos. 1 and 3 levels, on the north side of the air shaft, the ground has been stoped out, varying in length from one hundred feet at No. 1 level to fifty feet at No. 3 level. The main shaft is five by ten feet in the clear, and is timbered with round pine timber, which costs 6 cents per running foot. The dimensions of the air shaft are nine feet by four and one half feet. The ore shoot is three hundred and twenty feet in length, and pitches to the north. Stopes have been run in it in places two hundred feet in one line. About one thousand eight hundred gallons of water per hour is the amount coming into the mine during the dry season; but in the winter twice that amount is pumped to the surface by a line of three pumps, one six-inch Cornish plunger, one six-inch jackhead, and one six-inch Cornish lift. Giant and Safety Nitro are the explosives in use in the mine, and about two pounds of powder is the amount necessary to extract a ton of ore. Sixty pounds of steel are consumed each month.

The cost of mining per ton of ore, including the running of levels, is $8. Lumber is delivered at the works from a sawmill distant from the mill ten miles, at a cost of $15 per thousand feet. The company has built a road from the main county road one and one half miles, at a cost of $2,000; and one and one half miles of ditch have been built at a cost of $500. The ore is transported from the shaft to the reduction works at a cost of 8 cents per ton. The mill belonging to the property is a ten-stamp wet-crushing mill of eight hundred and fifty-pound stamps, which are dropped ninety times per minute under a six-inch drop, crushing two tons per stamp each twenty-four hours. The shoes and dies are of chrome steel, and cost 10 cents per pound, and the wear is estimated at 7 cents per ton. Brass wire screens of fifty-mesh are used, four feet in length by eight inches in width inside of the frames; they are slightly inclined. The aprons are twelve feet in length by four and one half feet in width, and the pulp runs from them into sluices eighteen inches in width by eighteen feet long. All are covered by silver-plated copper plate. Copper plates are also used inside of the battery, the back plate being ten inches in width and the front plate six inches. One and one half inches per foot is the inclination given to the aprons and sluices. Challenge feeders are used. Of the gold recovered 75 per cent is found in the battery, and 25 per cent is the product of the outside plates. Six Frue concentrators, with Morris canvas tables, is the concentrating plant in use.

The character of the ore is crystalline quartz, containing sulphurets of iron and galena, and pyrrhotite (magnetic pyrites). The value of the sulphurets averages $160 per ton in gold and about twenty ounces of silver. They are shipped to and worked at Maltman's Reduction Works in Sonora. Thirty men are employed in the mine, three in the mill, and six outside, making a total of thirty-nine employés. The average wages paid in the mine is $3 per day, and in the mill the average is $3 50 per day, while outside labor averages $2 50 per day. The power for the mill is supplied by a four-foot Knight wheel, using twenty-eight inches of water under a pressure of five hundred and fifty feet.

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Width of sluice	14 inches.
Length of sluice	22 feet.
Kind of feeders	Challenge.
Average wages paid in mine	$3 per day.
Average wages paid in mill	$3 50 per day.
Average wages paid for outside work	$2 50 per day.
Quantity of water used for power	55 inches.
Cost of water	15 cents per inch.

In this district are also several mines being prospected.

THE CARY MINE.

This mine is six hundred feet in length by six hundred feet in width. A shaft has been sunk to a depth of sixty feet, and the ledge is eighteen inches in width. The ore carries 4 per cent of sulphurets, and is said to pay $30 per ton in free gold. It is hauled to the works of Albert Maltman, at Sonora, for reduction.

THE LIVE OAK MINE.

This claim is the property of the Black Oak Company. A shaft has been sunk eighty feet in depth, and shows a vein of three feet in width. The claim is nine hundred feet in length by six hundred feet in width. The ore carries a large percentage of sulphurets, and is very similar to the Black Oak quartz, and is said to be very rich.

ARRASTRAVILLE MINING DISTRICT.

This district derives its name from the great number of arrastras that were in operation there, of which a great many are yet at work on small veins which were very rich on the surface. Turn Back Creek, which courses northeast through this district, seems to be the dividing line between the granite and the slate, the latter of which is on the eastern side of the creek. The principal mine of the district which is now being worked is the Sonora Consolidated.

THE SONORA CONSOLIDATED MINE.

This mine is situated in Secs. 21 and 28, T. 2 N., R. 16 E., M. D. M., and is one thousand five hundred feet in length on the vein by six hundred feet in width. Its works are at an altitude of two thousand seven hundred and fifty feet above sea level. The mine is eleven miles northeast from Sonora by good wagon road. The vein courses north 18 degrees east, and dips to the east at an angle of 45 degrees, and averages two feet in width. The hanging wall is a highly mineralized clay slate, and on the foot wall the slates are of a siliceous character. Dikes of hornblendic porphyry are occasionally encountered in crosscutting, which, when met, retard progress materially on account of the extreme hardness. The mine is opened by two tunnels and one shaft. The upper tunnel is driven on the vein toward the north two hundred and fifty feet, and strikes the incline shaft two hundred feet from its top. No. 2 tunnel is a crosscut for three hundred feet, running nearly at right angles to the vein, and strikes it at a point two hundred and ninety-five feet south of the incline shaft. Both Nos. 1 and 2 drifts have been driven north of the shaft; No. 1 seventy feet beyond it, and No. 2 eighty-five feet. The

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incline shaft is four hundred and twenty feet in length, and where it intersects No. 2 drift, at a depth of three hundred and twenty-five feet from its top, a large chamber has been excavated which contains the hoisting works, to which power is supplied from a ten-inch water pipe brought down the shaft to a five-foot Sieber waterwheel. Eighteen inches of water are used under three hundred and fifty-five feet of pressure. From this point the shaft continues to a depth of ninety-five feet below the hoisting works.

At a point seventy feet below the hoisting station, on the incline, a drift has been run south eighty feet and north thirty feet. In the south drift, fifty-five feet from the shaft, a winze has been sunk to a shallow depth, and an upraise made fifteen feet high, where the ore shows a great deal of free gold. As yet very little stoping has been done below No. 2 level, but from it to the surface the pay shoot has been nearly extracted. The shoot has averaged two hundred feet in length, and stopes have been driven in it in places two hundred and forty feet continuously. The pay ore pitches slightly to the north. Hercules powder, both Nos. 1 and 2, is used as the explosive. The cost of drifts has averaged $5 per foot, the crosscut tunnel $30 per foot, the extraction of ore costing $2 25 per ton. The company has built a ditch four miles in length at a cost of $1,500, which supplies them with an abundance of free water for both mill and hoist.

The character of the ore is crystalline quartz, with sulphurets of iron and free gold. The means of reduction is a five-stamp wet-crushing mill, which has been so constructed that five additional stamps can be placed in position in a short time. It in fact only lacks the stamps and mortar, the frame and connections having been made for ten stamps. The stamps are of one thousand pounds weight each, and are dropped six inches eighty-five times per minute, crushing two tons each every twenty-four hours. Chilled iron shoes and dies are used, manufactured by the foundry at Sonora, and cost 5 cents per pound there. The screen is of brass wire, No. 60, and its dimensions are four feet in length by nine inches in width inside of the frame. The apron is four feet by twelve feet in length, covered with silver-plated copper plate. A front plate is also used inside of the battery, four feet long by six inches wide. A Tullock ore feeder is used in the mill. About 2 per cent of sulphurets is contained in the ore, which are concentrated on Morris canvas tables and are shipped for reduction. Eight men are employed in the mine, receiving $2 50 per day, and two men in the mill receive the same pay.

Altitude	2,750 feet.
Length of ore shoot	200 feet.
Length of ore shaft from surface	420 feet.
Vertical depth reached in mine	280 feet.
Quantity of water raised in twenty-four hours	20,000 gallons.
Character of hanging wall	Clay slate.
Character of foot wall	Siliceous slate.
Kind of powder used	Hercules Nos. 1 and 2.
Cost of mining per ton of ore	$2 25.
Cost of crosscut tunnel	$30 per foot.
Kind of timber used in mine	Round pine.
Cost of timber	5 cents per foot.
Length of ditch built	4 miles.
Cost of ditch	$1,500.
Character of ore	Quartz, with iron pyrites and galena.
Character of works	Wet-crushing mill.
Number of stamps	5, with frame for 10.
Weight of stamp	1,000 pounds.
Drop of stamps	6 inches.

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National air compressor is used in the mine, running four fifteen-inch National drills. The cost of mining per ton of ore is estimated at $1 50 per ton. The main shaft is five feet by eight feet in the clear and is timbered with ten by twelve-inch square timber, which costs $15 per thousand feet, delivered.

The company has built a road one half of a mile in length at an expense of $500, and nine miles of ditch have been constructed at a cost of $8,600. The method of reducing the ore is by free-milling process, and the mill is located almost at the mouth of the shaft. The ore is quartz of a ribbon character, carrying 2 per cent of sulphurets of iron. The mill is a twenty-stamp mill, each stamp weighing eight hundred and fifty pounds, which drop ninety-eight times per minute under a four-inch drop, and two tons each twenty-four hours is the duty per stamp. The discharge is seven inches high from the dies when new. The ore is first thoroughly crushed by a large Blake crusher. The aprons are four feet in width by fourteen feet in length, and the pulp runs from them into sluices fourteen inches in width and twenty feet long. The aprons and sluices are all covered with silver-plated copper plates, and the inclination given to the aprons and sluices is one and a half inches per foot. Chrome steel shoes are used in the mill, and white iron dies, averaging in cost 8 cents per pound. The screens are No. 1 round-punched, and inside of the frames measure four feet in length by eight inches in width. Hendy improved feeders are used in the mill. Sixty per cent of the gold recovered is saved in the battery and 40 per cent on the outside plates. Eight Frue concentrators are in use in the mill. The value of the concentrates is $70 per ton average, and are hauled to Maltman's works at Sonora for reduction. Eighteen men are employed in the mine at an average pay of $2 50 per day, and in the mill four men are employed, the average wages being $3 per day. Six men are employed outside, and their wages average $3 per day.

Hoisting is done by a six and a half-foot Pelton wheel, using sixty inches of water under six hundred and twenty feet of pressure. This power also runs the air compressor. The works are supplied with a ten-inch by eighteen-inch engine and a forty-eight-inch by twelve-foot tubular boiler in case of accident. The mill is run by a six and a half-foot Donnelly wheel, using twenty-five inches of water under a six hundred and twenty-foot head. A two and a half-foot Knight wheel runs the rockbreaker with the same pressure, using fifteen inches of water. Water costs 20 cents per inch for twenty-four hours.

Altitude (aneroid reading)	275 feet.
Length of shaft	900 feet.
Quantity of water raised	40,000 gallons in 24 hours, in winter; in summer, nominal.
Character of walls	Slate.
Kind of powder used	Safety Nitro.
Cost of mining ore per ton	$1 50.
Number of feet main shaft timbered	Entire.
Kind of timber	10 by 12 sawed pine.
Cost of timber	$15 per thousand.
Length of road built	1½ miles.
Cost of road	$500.
Length of ditch built	9 miles.
Cost of ditch	$8,500.
Character of ore	Ribbon quartz.
Character of works	Wet-crushing mill.
Number of stamps	20.
Weight of stamp	850 pounds.
Drop of stamps	4 inches.
Drops of stamps per minute	98.

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Height of discharge above dies	7 inches.
Size and character of screens	No. 1 round-punched.
Duty of stamp	2 tons each per 24 hours.
Kind of shoes	Chrome steel.
Kind of dies	Chilled iron.
Dimensions of aprons	4 by 14 feet.
Width of sluices	14 inches.
Length of sluices	20 feet.
Kind of feeders	Hendy's improved.
Kind of concentrators	Frue.
Number of concentrators	8.
Percentage of gold recovered saved in battery	60 per cent.
Percentage of gold recovered saved on plates	40 per cent.
Percentage of sulphurets	2 per cent.
Value of sulphurets	$70 per ton.
Number of men in mine	18.
Number of men in mill	4.
Number of men outside	6.
Total number of employés	28.
Average wages in mine	$2 50 per day.
Average wages in mill	$3 per day.
Average wages outside labor	$3 per day.
Quantity of water used in mill	25 inches.
Quantity used for hoist and compressor	60 inches.
Quantity used for rockbreaker	15 inches.
Cost of water	20 cents per inch.

THE LADY WASHINGTON MINE.

This mine is the south extension of the Dead Horse Mine. Two tunnels have been run into the mine on the vein, and from the bottom tunnel a shaft has been sunk at about three hundred feet from its mouth to a depth of two hundred feet. The lower tunnel is about three hundred and fifty feet below the surface. The ledge averages three feet in width, and the ore contains about 1½ per cent of sulphurets. Some ore has been stoped and worked from the mine, and is said to have yielded well. Work has been stopped for some time, but I understand that it is soon to be resumed.

THE NEW ALBANY MINE.

This mine is situated about one mile southeast from the town of Summerville in Sec. 9, T. 1 N., R. 16 E. The vein courses northeast and southwest, and is nearly parallel with the vein of the Consolidated Eureka. It dips to the east and averages about three feet in width. Several tunnels have been run into the hill on the vein, and from the bottom tunnel a shaft has been sunk several hundred feet, showing a strong vein from top to bottom. The formation of the walls is slate, and the character of the ore is ribbon quartz, carrying 2 per cent of sulphurets. There is a ten-stamp mill on the property, and its owners are preparing the mine for active operations.

THE BUCHANAN MINE.

This mine is situated in an air line about five miles southeast of Summerville, and about eleven miles a little south of east from Sonora, in Sec. 27, T. 1 N., R. 16 E., and by wagon road about twenty-eight miles from the latter place. The mine was located in 1856, and its dimensions are three thousand feet in length by six hundred feet in width. Its works are at an altitude of three thousand three hundred feet above sea level. The vein courses east and west about 27 degrees

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south, and dips to the south at an angle of about 56 degrees. Its average width is ten feet. The mine has been opened by a tunnel and shaft. The tunnel is two hundred and forty-one feet in length, and strikes the incline shaft one hundred feet below the top. This tunnel has cost $3 50 per foot, and is timbered for about fifty feet of its length with round pine timber, which costs 4 cents per foot. The main incline shaft is five hundred feet in length, and its pitch is 58 degrees, attaining a vertical depth of three hundred and fifty feet at the fifth level. On this level, three hundred feet east from the above described incline, No. 2 incline is sunk from it two hundred and fifty feet in depth at an angle of about 45 degrees. Seven levels have been run. No. 1 is ninety-four feet deep, running east two hundred and forty-one feet, and west two hundred and fifty-five feet; No. 2 is ninety-four feet below No. 1, and runs east one hundred and seventy-five feet, and west three hundred and twenty-four feet; No. 3 is eighty-eight and one half feet below No. 2, and runs east three hundred and forty-one feet; No. 4 is seventy-six feet below No. 3, and runs east six hundred and ten feet, and west two hundred and seventy feet; No. 5 is eighty-one feet below No. 4, and runs east three hundred and thirty feet; No. 6 is sixty-one feet below No. 5, and runs east fifty feet and west eighty feet; No. 7 is ninety-two and one half feet below No. 6, and runs east forty feet. Stoping has been done from each level.

There are two ore shoots, one of which is three hundred feet in length, and the length of the other has not yet been determined. It is a parallel ore shoot, distant thirty feet east of the vein. Continuous stopes of three hundred feet in length have been run in places. The formation of the walls is slate. About fifty thousand gallons of water is the maximum amount coming into the mine, which amount varies according to the season. A No. 3 Hooker pump and a Worthington pump, with two and a half-inch discharge, keeps the mine clear of water. A Rix air compressor is used, running two National drills. Hercules powder is the explosive used in the mine, and one half pound is the amount used in the extraction of one ton of ore. The cost of mining per ton is $2. The running of levels costs $6 per foot. The dimensions of the main shaft are five feet by nine feet in the clear, and it has cost $27 per foot to sink it, and is timbered with sawed yellow pine for nearly its entire length; the pine costing $7 50 per thousand feet, the sawing being done on the property. Round pine timber costs 4 cents per running foot. Twenty-five miles of road have been built and graded by the company at a cost of about $20,000, and five miles of lumber flume have been constructed at a cost of $5,000.

The cre is transported to the mill by means of a wire tramway, six hundred and fifty feet in length, at a cost of 6 cents per ton. The character of the ore is ribbon quartz, carrying 1 per cent of iron pyrites and galena, the same being reduced by a wet-crushing mill of twenty stamps; each stamp weighing eight hundred and fifty pounds, and dropping seven inches ninety times per minute. The height of the discharge is five inches when the dies are new, and the amount crushed per stamp each twenty-four hours is two tons. The screens are No. 11 slot-punched, and inside the frames the screen surface is six inches by forty-eight inches. Chrome steel shoes and dies are used in the mill, and the wear is estimated by Mr. Hamilton, the Superintendent, at 6 cents per ton of ore crushed. The aprons may be said to be divided into two parts. The

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top aprons are four feet in width by six feet in length, and the pulp is dropped two inches on aprons three feet eight inches in width by six feet in length. From this are sluices, eighteen inches wide by sixteen and a half feet in length. The aprons have an inclination of one and a half inches to the foot, and the aprons and sluices are covered with silver-plated copper plate. Challenge feeders are in use in the mill. Plates are also used inside the batteries, being six inches in width by forty-four inches in length. About 75 per cent of the gold recovered is saved in the battery, the product of the outside plates being 25 per cent. Eight Frue concentrators are in use in the mill, serving to concentrate 1 per cent of sulphurets contained in the ore, whose average value is $66 per ton. The plant has a three-ton reverberatory furnace and chlorination works for the reduction of sulphurets. A contract for the working of the sulphurets has been given at $14 per ton and the use of the works. The sulphurets are allowed to accumulate until a sufficient quantity is on hand to make a run.

There are thirty men employed in the mine, receiving wages averaging $2 50 per day. In the mill are five men whose wages average $3 per day; and outside labor, which includes blacksmiths, teamsters, etc., averages also $3 per day, there being ten men employed outside, making the total number of employés forty-five men. The power for hoisting is a ten by eighteen-inch cylinder, horizontal engine, there being two boilers fifty-four inches in diameter by sixteen feet in length, which supply steam for the air compressor and pumps as well as for the hoist. A short distance above the fifth level, where the level encounters the lower incline shaft, a chamber has been excavated and a six by ten-inch double cylinder engine is placed there, and used for hoisting a self-dumping skip from the workings below. The mill is supplied with power by a twelve by twenty-inch cylinder engine, which is supplied with steam by a boiler of the same dimensions as those in use at the hoisting works. Three cords of wood are used in the hoisting works per day and four cords are used in the mill. It is pine wood and costs $3 per cord delivered at the works. During the year the principal work done in the mine was the retimbering of the main shaft and other portions of the mine. The work on the flume by which power is to be created at the river and transmitted by compressed air to the works, one and one half miles distant, has been vigorously pushed, and will be continued to completion.

Altitude	3,300 feet.
Length of ore shoot	800 feet.
Length of upper incline	480 feet.
Length of lower incline	250 feet.
Vertical depth reached	About 600 feet.
Maximum quantity of water raised	50,000 gallons in twenty-four hours.
Character of walls	Slate.
Kind of powder used	Hercules No. 2.
Cost of mining per ton	$2.
Kind of timber used	Round and sawed pine.
Cost of round timber	4 cents per foot.
Cost of sawed timber	$7 50 per thousand.
Length of road built	25 miles.
Cost of road	$20,000.
Length of ditch built (flume)	5 miles.
Cost of flume	$5,000.
Character of ore	Ribbon quartz, with sulphurets.
Number of stamps	20.
Weight of stamp	850 pounds.
Drop of stamps	7 inches.
Drops per minute	90.

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This tunnel cuts two ore shoots, and in the first of them, about two hundred feet from the mouth of the tunnel, a winze has been sunk fifty feet in depth, and a small quantity has been stoped out to the tunnel level. The tunnel north from the gulch has been run four hundred feet on the vein, and cuts a shaft sunk on the hill one hundred and fifty feet from its top. This shaft has been sunk on the vein three hundred feet in depth, and the above described tunnel is its second level. It continues north from the shaft sixty feet. Fifty feet above the level of the tunnel, No. 1 level has been run north also sixty feet and south one hundred and fifty feet. At one hundred feet from the shaft an upraise has been made on this level forty-five feet to the surface. Below the tunnel, or No. 2 level, No. 3 level runs north thirty feet and south one hundred and twenty-five feet. Eighty feet deeper, and one hundred feet below No. 3, is No. 4 level, running south fifty feet. From No. 3 level to the surface, much ore has been stoped of a good character. The tunnels have cost $4 per foot, and they are two hundred and fifty feet vertically below the surface.

At present only one ore shoot is being worked, it averaging about thirty feet in length. The shoots all pitch to the north, there being three separate and distinct shoots in the mine. Safety Nitro powder is used as the explosive. The cost of mining per ton is $2 50. Lumber is delivered at the mine for $20 per thousand feet. About one and one half miles of road have been built by the company at a cost of $500, and two miles of ditch at a cost of $400. The character of the ore is a white friable quartz, containing a very small percentage of sulphurets of iron and galena. The means of reducing the ore is a ten-stamp wet-crushing mill, each stamp weighing six hundred and fifty pounds. They are dropped six inches ninety times per minute. The height of the discharge is five inches, and each stamp crushes one and one quarter tons every twenty-four hours. Chrome steel shoes and dies are used, and cost 10 cents per pound. Brass wire screens No. 50 are in use, and are four feet in length by six inches in width inside of the frames. The aprons are four feet in width by sixteen feet long. No sluices are used in the mill. A six-inch front plate is used inside of the battery. The mill has two Challenge ore feeders. Sixty-five per cent of the gold recovered is saved inside the battery, and 35 per cent is taken from the outside plates. Six men are employed in the mine at wages averaging $3 per day, and one man is in the mill at $3 50 per day, the mill running only twelve hours. One man outside is paid $2 50 per day. Both mill and hoist are run by water power, which is free. At the mill the pressure is five hundred feet, and at the hoisting works five hundred and fifty feet.

Altitude	2,700 feet.
Vertical depth reached in mine	350 feet.
Character of walls	Slate.
Kind of powder	Safety Nitro.
Cost of mining	$2 50 per ton.
Cost of tunnels	$4 per foot.
Kind of timber used	Round pine.
Cost of timber	3 cents per foot.
Length of road built	1½ miles.
Cost of road	$500.
Length of ditch built	2 miles.
Cost of ditch	$400.
Character of ore	Quartz.
Character of works	Ten-stamp mill.
Weight of stamps	650 pounds.
Drop of stamps	6 inches.
Drops per minute	90.
Height of discharge	5 inches.

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VENTURA COUNTY.

By Dr. Stephen Bowers, Assistant in the Field.

Since my last report the line between Ventura and Santa Barbara Counties has been officially established, placing it some four miles west of where it originally ran, and adding about one hundred square miles to the former county. This county, which includes San Nicolas and Anacapa Islands, now contains one million one hundred and eighty-four thousand two hundred acres, or one thousand eight hundred and fifty square miles. The tillable land embraces about one half of the territory; is well watered and exceedingly fertile.

MINERAL OILS.

Since my last report work has gone steadily forward in the mineral oil belt in this county, and the output of mineral oils has been very encouraging. The following is a statement of what has been done:

SESPE OIL WELLS—HEAD OF TAR CREEK CAÑON.

Well No. 16 is located about two thousand feet northwest of No. 13. It was drilled to a depth of about eight hundred and fifty feet, and started off at about thirty barrels daily.

No. 17 is located about six hundred feet northwest of No. 12. It was drilled to a depth of four hundred and twenty feet, and produced thirty barrels daily.

No. 18 is located about eight hundred feet south of No. 16. It was drilled to a depth of nearly six hundred feet, and started off with a daily yield of about sixty barrels.

No. 19 is located about one and a half miles northwest of No. 16. It is about nine hundred feet deep, and is dry.

No. 20 is located about five hundred feet north of No. 16. It was drilled to a depth of six hundred and sixty-five feet, and yielded thirty barrels daily.

No. 21 is located about five hundred feet south of No. 1. It was drilled to a depth of seven hundred and ten feet, and yielded thirty barrels a day.

No. 22 is located about four hundred feet south of No. 10. It reached a depth of about three hundred and ninety feet, and started off at thirty barrels per day.

No. 23 is located about four hundred feet south of No. 2. It was drilled to a depth of about six hundred and forty-five feet, and started off at two hundred and fifty barrels daily.

No. 24 is located about four hundred feet north of No. 4. It was drilled to a depth of eight hundred and fifty feet, and yielded two hundred barrels per day.

No. 25 is located about one thousand feet southeast of No. 1. It was

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TORREY CAÑON OIL WELLS.

Torrey Cañon is about two and a half miles south of Piru Station, on the Southern Pacific Branch Railway, Ventura Division, and has been developed within the past year.

Well No. 1 is located about fifteen hundred feet east of the most northwesterly corner of Rancho Simi, and about three hundred feet south of the line of the Rancho Simi and the Rancho San Francisco. It was drilled to a depth of six hundred feet, and started with forty barrels daily.

No. 2 is located about four hundred and fifty feet east of No. 1. It was drilled to a depth of four hundred and fifty feet, and started off at fifty barrels.

No. 3 is located about four hundred feet west and a little south of No. 1. It was drilled to a depth of about seven hundred and fifty feet, and produced about forty barrels daily.

No. 4 is located about six hundred feet east of No. 2. At a depth of one thousand feet it produced twenty-five barrels a day.

No. 5 is located about four hundred feet north of No. 1. It was drilled to a depth of eight hundred feet, and started at fifty barrels per day.

No. 6 is located about three hundred and fifty feet north of No. 5. It is now drilling at six hundred feet, and produces some ten barrels daily.

Bard, Hardison & Stewart Well No. 1 is about two hundred feet west of Torrey Cañon Oil Well Company's Well No. 3. It was drilled to a depth of about six hundred feet, producing but a small amount of oil with a large flow of water.

A pipe-line has been laid to Buckhorn Station, three and a half miles distant, where a tank and loading station has been established for the product of the Torrey Cañon Wells.

The company now has one hundred miles of pipe-line and sixty miles of telephone line connecting with their central works at Santa Paula.

The company's refining works is producing good illuminating and lubricating oil, also the naphthas and asphaltum. They own fifty-four oil-tank cars, which are run over the Southern Pacific Railroad lines, beside facilities for shipment by steamer from Ventura and Hueneme.

BITUMINOUS ROCK.

A body of good bituminous rock is being worked in Diablo Cañon, some five miles from Ventura, by the Ventura Asphalt Company. It is not found in very well-defined strata, but crops out in pockets in several places. It has, however, a general dip to the south of about 45 degrees. On the first level about one thousand two hundred tons have been taken out. Twenty-six feet below this a tunnel has been run for a distance of two hundred and fifty feet, and from which about six hundred tons have been removed, making one thousand eight hundred tons as the yield of the deposit to date. The bitumen is pronounced of a superior quality, and the demand seems fully equal to the supply.

A large deposit of bituminous rock has been discovered in Torrey Cañon, on the south side of Santa Clara River, opposite Piru Station, and another in the Upper Ojai Valley; but neither have, as yet, been worked. Several other deposits have been found in various parts of the county.

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BUILDING STONE.

Ventura County has, probably, one of the largest known deposits of brown sandstone. Beginning near the seashore on the west side of Ventura River, I have traced it northeasterly for a distance of about thirty miles. There is an outcrop in Diablo Cañon, some two miles from the ocean, where the strata are horizontal. Some five miles distant, on the Ventura River, there is an extensive vertical exposure, which has been worked by the Ventura Brownstone Company. From this point many tons have been quarried and shipped to Los Angeles and San Francisco. Several miles northwest of the last named place, on the Beekman Ranch, near the mouth of the Matilija Cañon, there is another horizontal exposure. This appears again on the western side of the Ojai Valley, again on the Gridley Ranch. It then dips under Topa Topa Mountain, and is exposed by the gorge of the Sespe. In ascending this stream, one meets with large bowlders of this stone, many of which are quarried advantageously. When first met *in situ* it is vertical, but becomes more horizontal as the stream is ascended.

East of this, as we cross from Tar Creek to Hot Spring Cañon, it assumes nearly a horizontal position, forming what is known as the "Stone Corral." It is nearly four miles wide at this point, the longer axis being nearly east and west. Another outcrop may be seen some miles east in descending the trail into Agua Blanca Cañon.

As far as I have been able to trace this vast deposit, I have found the strata, with a single exception, nearly horizontal on the north side. In one place the exposure shows a thickness of about two thousand feet. Many tons of this handsome rock have been quarried and shipped from Sespe.

UPPER SESPE.

The Upper Sespe is only accessible via Malilija Cañon, through which flows an important tributary of the Ventura River. The elevation of the mouth of the cañon is one thousand and fifty feet above the sea level. The cañon is bounded on either side by high mountains composed of stratified rocks bent and tilted at every conceivable angle. In this cañon are several mineral springs of various degrees of temperature from cold to boiling, and are noted for their health-giving properties.

At a distance of about ten miles from where the cañon debouches into the Santa Ana Plain, there is a fork, or prong, coming in from the north, and along which the trail makes its way. The elevation here is one thousand seven hundred and fifty feet. The North Fork is some ten miles long, and is a deep, narrow gorge of most tortuous character, and filled with bowlders of sandstone, some of which are of immense size. In some places walls of rock rise to a height of more than a thousand feet, and present a very picturesque appearance. Dikes frequently protrude from the face of the mountains on either side and extend across the cañon, making this a difficult and dangerous trail. The rise in the ten miles is about two thousand four hundred feet to where a steep hill is encountered sloping at an angle of about 45 degrees. A toilsome, zigzag trail finally brings the explorer to the summit, where the barometer marks an altitude of five thousand three hundred feet. The trail then descends a dark cañon for a distance of four miles, studded with pines, fir, and

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oaks, and along which a cold mountain stream finds its way until the Sespe is reached.

We descended the stream for a distance of four miles to certain cienega flats, where there is an interesting exposure of rock strata. On the south side of the stream they are nearly vertical, and rise to the height of about one thousand feet. The valley is about six hundred feet wide, and with the creek bed is underlaid with shale dipping to the north at an angle of fifteen degrees. Over this shale on the north side rests six hundred feet of sandstone intercalated with shale; the upper portion is conglomerate sandstone, large bowlders of which have fallen from the first bench, or rim, and lodged on the side of the declivity or found their way to the valley. Several forms of granite occur, including pegmatite or graphic granite; also, syenite, porphyry, gneiss, quartzite, ironstone, jasper, chalcedony, micaceous shale, etc.

After reaching the rim of the first escarpment six hundred feet above the creek bed, the edges of the upturned strata are denuded, forming a sort of a trough several hundred feet wide, when it begins to rise again and terminates in the south rim of Pine Mountain six thousand five hundred feet above the sea level. The entire exposure of the rock strata from the bed of the Sespe to the top of Pine Mountain cannot be less than two miles. Some of it is highly metamorphic. At an elevation of five thousand one hundred and twenty-five feet a large spring of cold sulphur water breaks out from under a stratum of metamorphic sandstone. Near the elevation is a stratum of calcareous sandstone about four hundred feet thick, which is highly fossiliferous. Here I obtained the following miocene fossils:

Ostrea titan, *Conr.*
Dosinia conradi, *Gabb.*
Pecten discus, *Conr.*
Astrodapsis antisellii, *Conr.*
Turritella hoffmani, *Gabb.*
Turritella jewetti, *Cpt.*
Arca microdonta, *Conr.*
Cardium meekianum? *Gabb.*
Mulinia densata, *Conr.*
Siliquaria edentula, *Gabb.*
Crassatella collina, *Conr.*
Saxidomus gibbosus? *Gabb.*
Balanus estrellanus, *Conr.*
Dosinia mathewsonii, *Gabb.*
Tellina bodegensis? *Hds.*
Chione mathewsonii? *Gabb.*
Macoma inquinata, *Desh.*
Neverita callosa, *Gabb.*
Macoma calcarea, *Chem.*
Glycimeris generosa, *Gld.*
Pinna alamedensis? *Yates.*
Glycimeris estrellanus, *Conr.*
Chama pellucida, *Sby.*
Turbinella cœstus, *Brood.*
Chrysodomus ——— ?

We traced the uplift for a distance of about twelve miles westward and two miles east of the cienega where we were encamped. Five miles west is a transverse opening in the rocks through which a small stream has cut its way, and along which is located the Cuyama trail. The exposure here is grit rock, standing out prominently on the north side of the Sespe to the height of two hundred feet, the summit being five thousand feet above the sea level. Ascending the trail for a distance of about four miles, I obtained some good fossils at an elevation of five thousand four hundred feet, some of which are named above. The bed of this small stream contains small garnets mingled with the sand. It has also been reported that some rubies have been found in this locality, but, so far as I have been able to ascertain, close investigation proved them to be garnets. It has also been reported that diamondiferous sand has been found in this place, but this, too, lacks confirmation. The fossils are most probably Miocene bordering closely upon Eocene.

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gorge, from which the hills rise steeply, at many points with vertical breaks, to an altitude of over one thousand five hundred feet. The subjoined topographical map will show this better than any description could do. The slopes are covered with shrubs or brush ("chaparral") and herbaceous vegetation, which includes the common gray as well as the blue-flowering sage (a famous plant for bee pasture) and a tall, rough grass ("cane grass"). This covering of vegetation is advantageous in preventing landslides and the washing away of the slopes and, also, in tempering the occasional heats of summer; but the regular sea breeze, which finds its way into the valley every afternoon, renders the climate equable and pleasant.

On the slopes on both sides of the valley there occur outcrops or surface indications of the presence of asphalt. They are found in many of the ravines where the vegetation has been washed away, and the first indication of the mineral noticed in the main cañon was the presence of huge blocks (since mined away) that had tumbled down from the sides and were carried some distance by the winter floods. The outcrops or "prospects" that have been somewhat closely examined or worked are indicated on the map and are numbered from one to six; but a much larger number has been observed. The surface has, however, been so much disturbed by slides that is difficult to distinguish a true outcrop from merely accidental occurrences of the mineral, without considerable work in stripping. "Float" of the asphalt has frequently been found in the ravine, sometimes in blocks tons in weight.

CHARACTER OF THE LODE.

The lode known at present as the "main vein" presents an excellent illustration of the general character of the asphalt deposits of the locality; which are true fissure veins in a mass of gray siliceous clay.

This vein was indicated on the surface of the ground by a mere seam of some seven to fifteen inches thickness; but when stripped it was found to increase rapidly, both horizontally and downward, so that at the depth of sixty-six feet from its surface cropping and sixty feet horizontally from the same, its thickness is five feet, while at the same time the material has improved in quality.

The strike of this vein is west 30 degrees north; its pitch, 65 to 70 degrees south 30 degrees west.*

While going in upon this vein for one hundred feet in an open cut, it was found to expand into several "pockets" of seven to as much as sixteen feet in diameter, from which great masses of the asphalt material were extracted; the whole output from this cut alone was one thousand four hundred tons. At one point a wall of the "ore" appeared sideways overhead. This proved to be a "spur" vein joining the other from the left (southwest) at an oblique angle, its strike being northwest, pitch 42 degrees due southwest, with a thickness of three to four feet, increasing to six feet of clear asphalt about ninety feet from the entrance of the cut. There being at the time a heavy demand for the material, the "main vein" was for the time being abandoned for the "spur," which was followed on an incline for thirty-eight feet, with a width of ten feet, until the level of the present gangway was reached, twenty-six feet below the

* The variability of thickness and form renders all these measurements only approximate; magnetic bearings are given; var. 15 degrees east.

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occurs. This fact has been demonstrated by the direct microscopic comparison of the asphaltic mass, leached of its bitumen, with the wall rock. It is also confirmed by the frequent occurrence of the fossil shells of the formation within the veins; also, by the occurrence of gravel, which, when deprived of its bitumen, turns out to be the same wall material in small masses rounded by attrition and solidified by the crystallization of some of the ingredients. All this, together with the sharp definition of the hanging wall, and sometimes of both walls, from the vein mass, demonstrate beyond cavil that the vein material is the result of a long-continued kneading process, by which the softened bitumen has been so intimately and uniformly mixed with the comminuted wall rock that upon cross-sections of six feet only small differences of composition appear, which, in the averages, become practically insignificant.

The following table of assays made from samples collected by myself with special care exhibits these points:

Assays of Asphalt from Ventura Mine.

	Number	Name.	Loss at 212 Deg. F., Water and Volatile Oil	Hydro-Carbons	Fixed Carbon	Per Cent of Fixed Carbon in Bitumen	Total Asphaltum	Averages	Ash.
Opening No. 1. Main vein. Room 1, 51 feet in.	1 *a*	Near foot wall, room 1	2.45	15.26	7.16	31.9	22.42		75.13
	1 *b*	22 inches from foot wall	2.30	15.58	6.31	28.8	21.89	21.2	75.81
	1 *c*	18 in. from hanging wall	3.04	17.01	5.51	24.7	22.52		74.44
	1 *d*	Near hanging wall	2.45	11.29	6.53	37.3	17.82		79.73
Opening No. 1. Spur vein.	1 *e*	Foot wall clay	4.25	5.62	4.38	43.8	10.00		85.75
	1 *f*	Vein mass near foot wall	2.42	11.81	3.47	22.7	15.28		82.30
	1 *g*	Same, 20 in. from foot wall	2.61	15.26	4.31	21.8	19.57		77.82
	1 *h*	Same, middle of vein	2.64	13.30	5.10	27.2	18.40	19.7	78.96
	1 *i*	Same, 20 inches from hanging wall	2.85	16.58	6.17	26.9	22.75		74.40
	1 *j*	Near hanging wall	2.52	17.10	5.58	24.6	22.68		74.80
Opening No. 2	2 *a*	Samples from dump	2.37	13.34	6.01	31.0	19.35	18.9	78.28
	2 *b*		2.89	12.85	5.72	31.0	18.57		78.54
Opening No. 4	*a*	Average mass from dump.	2.00	15.33	6.41	29.8	21.74	21.1	76.26
	b	Wedge between layers of shale	2.00	14.74	5.73	23.5	20.47		77.53
	4 *c*	Shining bitumen	----	------	------	------	79.55	------	20.45
Opening No. 5	5	Average mass	1.42	11.46	4.93	30.0	16.39	------	82.19

The results of the above assays may be stated as follows:

The *totals of bitumen* fixed at 212 degrees Fahrenheit, while ranging within the several veins from a minimum of 15.28 per cent to as much as 22.75 per cent, will in each case, on the average, be close upon 20 per cent—generally above. It should be noted that the results from openings Nos. 2 and 5, in which but little work has been done, can only be considered as representing "croppings," which, as a special examination shows, are always poorer in bitumen than the portions reached by deeper workings. Outside of the two veins of No. 1, No. 4 alone can count as

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opening, but also in those lying considerable distances apart, points unmistakably to a common origin. In other words, it goes far to prove that all the veins observed are offshoots of one and the same Mother Lode, to reach which might well form a heavy financial inducement.

GEOLOGICAL POSITION AND EXTENT OF THE VEIN-BEARING FORMATION.

The vein-bearing formation (a member of the Miocene-Tertiary) is a bed of siliceous, fine-grained clay of gray, or at times of yellowish-gray tint; almost throughout of massy structure, rarely somewhat shaly, and near the surface full of dislocations and slickensides. This clay forms a belt bearing nearly west (magnetic), or 15 degrees north of true west. Its width near the stream bed is about five hundred and twenty-five feet; it widens somewhat as we ascend the western slope, and at the level of "prospect No. 4" is approximately six hundred and seventy-five feet wide, the latter opening lying, apparently, close to its northern limit. Over all the belt thus outlined the clay material is very uniform, except that as we approach the summit of the coastward ridge, the strata are ill defined, and a calcareous shell conglomerate, with more or less gravel and many streaks and drops of bitumen, but offering no prospect of veins or pockets, replaces the clay, by an unconformity not specially investigated, as it does not bear on the question in hand.

While within the clay belt its structure is too obscure to indicate definitely its position as a stratum, the beds on either side define it plainly. On its upper or northern edge the formation is seen in the bed of the stream to be bituminous clay shale, thin-bedded, and often directly on edge, vertically, at other points with a slight dip either way. Its trend is practically magnetic west. Higher up on the slope the formation is covered by slides and wash, as to render definition difficult.

On the southern edge the line is more readily traced, but instead of the bituminous shale we find sheets of soft sandstone, alternating with unconsolidated sand, with a dip of 50 degrees (magnetic) north, but showing a tendency to curve to a steeper angle. This is more definitely shown on a ridge beyond prospect No. 2, where corresponding strata of more consolidated material (reddish sandstone) form on a hillside a curve ranging in dip from less than 45 to as much as 70 degrees. It is therefore predicable that the differences in the dip of the formations bordering the clay belt do *not* imply that it "wedges out" with greater depth; while on the other hand the complex structure of the adjacent country (in which horizontally bedded sandstones are seen crowning ridges whose sides show strata steeply tilted) precludes an exact prediction of the position these several beds may be found to occupy at greater depths.

ORIGIN OF THE VEINS.

Most probably the clay belt forms part of an inverted arch, of which the broken crown may have given an entrance to the soft asphaltic magma forced by pressure from below into the irregular cracks and fissures of the clay, and kneading its materials into it by the forced passage through the fissures filled with clay debris.

That this is not a fancy picture is plainly shown by the manner in which the veins of *argillo-asphaltite* approach the surface. This is best observed at openings Nos. 1 and 4, in each of which the fact is plainly

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not so much with a solid vein mass, as with a slide or creep down-hill from a higher-lying outcrop. The present aspect of this opening does not encourage its continuation, so long as much better prospects are in view elsewhere.

No. 6.—About two hundred feet distant from No. 5, and some seventy feet above it; seems more promising as to continuity, although only a little prospecting work has been done there. The face was covered with a slide at the time of my visit; but a small pile of ore got out some time ago showed promise of very good material.

Opening No. 4 lies on the same slope at an elevation of about one thousand one hundred feet, two hundred and sixty feet above the present (gangway) track at No. 1, and six hundred feet due northwest of the gangway entrance. Its face, some thirty feet high, is at the end of a cut forty-five feet long, and presents an excellent example of the peculiar manner in which these veins thin out and branch as they approach the surface. A figure alone could give an exact idea of its conformation; it resembles nothing so much as a broad hand with fingers expanded, tapering off downward into a wrist about two feet across, while the expanded palm, of more or less impure material, is quite six feet wide; the fingers tapering off to points within a few feet of the surface, excepting one, which is club-shaped. The body of the vein below is about vertical. Its strike cannot at present be closely measured, but is about 8 degrees south of west, therefore quite different from that of the ore bodies of No. 1. But in a mass like this, parallelism of veins cannot be expected any more than strict regularity in a vertical direction.

On this vein an incline sixty feet long, equal to forty-three feet vertical depth from the floor of the cut, has been sunk; so that here a total vertical depth of about seventy feet is exposed. Within these limits its thickness varies from a minimum of twelve inches to as much as three feet, there being a general increase as we descend, although not as regular or striking as at the "main vein" and its spur. As will be seen from the table of assays, the material of this vein, which is remarkably solid, is above the average in its percentage of bitumen. It is out of range with the rest of the openings and doubtless represents an independent fissure. On its selvedges there frequently appear veinlets of shining bitumen, the composition of which is given in the table of assays. These veinlets offer convincing proof of the pressure under which the vein was formed, squeezing out the surplus of bitumen.

As this vein lies quite near to the northern edge of the clay belt it will be important to prosecute the work here with a view to determining whether or not the dikes continue into the contiguous mass of bituminous shales.

Prospect No. 3 is at the foot of the slope, still on the right side of the creek, and over five hundred feet distant northward from the edge of the clay belt. Quite a prospect hole has been cut here, but the material is simply a bituminous shale, a little richer than the surrounding mass, and shows no indication of a vein or dike. It confirms the distinct impression conveyed by the whole aspect of the asphalt bodies, that their existence in an available form depends upon the gray clay.

Opening No. 2 lies on the opposite slope of the cañon, and a pretty wide cutting has been made, and a tunnel forty feet long has been run, in order to test the continuity of the vein, which here, as elsewhere, is

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inner slope of twenty-four feet, built of three-inch timbers; a bottom of four feet and a front wall of ten feet height, of one and one-half inch plank. They are so located that the cars of the present gangway dump very conveniently into them, while the wagons load from them with the greatest ease and expeditiousness.

From the above description and discussions the character, prospects, and value of this mine will be sufficiently apparent to the mining expert; but it may not be superfluous for me to express more definitely my own views in the premises.

There can be no question of the peculiar excellence of the material furnished by the mine, which is adapted to many practical uses that could not be subserved by the ordinary commercial materials of less fixity, natural firmness, and uniformity.

The question of its supply, that is, of the durability of the mine, is, perhaps, the most needful to dwell upon. In this regard I can but express my belief, based upon a personal knowledge of the formations on the Ventura and Santa Barbara coast lines, that the system of veins and dikes found in the Cañon del Diablo will be found to extend down to the level from which the petroleum springs of the Santa Barbara Channel derive their supply.

The borings made between the towns of San Buenaventura and Santa Barbara, the exposures at the Breitas near Carpenteria, and that at Goletas, beyond Santa Barbara, all of which I have formerly studied, point to the conclusion that the great reserve of petroleum and asphalt lies at some depth below the surface of the sea; and it is naturally to be presumed that the injection of the vein material at the Ventura Mine has its source at the same level. It is quite probable that with greater depths the asphaltic mass will gradually change to some extent; if so, it will certainly be in the direction of greater richness in bitumen. But from every indication I can unhesitatingly say that if the mine is not practically inexhaustible, it is certainly capable of supplying the heaviest demands likely to be made upon it for many years to come.

But while thus far the limited scale of the work has permitted a somewhat desultory mode of working with very good results, the time has certainly come when the mine must be taken in hand as a whole, with a definite and well designed plan of development. I cannot doubt that with such a plan, and with adequate financial means, it will long continue to be highly profitable.

E. W. HILGARD.

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streams, which, fed by the excessive rainfall of Post Glacial periods, washed out the smaller valleys, and thus assisted in molding the mountains to their present form, and distributing the waterworn debris upon the surface of the clays in the valleys below. The former channels of these streams are now either covered with alluvial soil, or their courses through the plain are marked by arroyos, destitute of water except after long rains; all evidence of their existence, other than the gravels they formed, are being rapidly obliterated by the plowshare and pluvial erosion.

The extreme western borders of the county are occupied by a portion of the Coast Range, while a tongue of rolling hills, which commences a few miles to the northeast of Cacheville, extends with broadening radius toward the northwest corner of the county.

Between these hills is a large valley, called Hungry Hollow, which is devoted to the growing of wheat and to stock raising; while between Putah and Cache Creeks the land gradually slopes from the Coast Range to the Sacramento River.

Although the minerals in the mountains on the western side of the county are not to be overlooked, and the geological features influencing the character of the soil require attention at the hands of the Mining Bureau, still the hydrographical features are of such supreme importance that we commence a wider field of geological inquiry, by collecting and placing in tangible form the scattered records and observations that have been made concerning the water and the formations in which a subterranean supply of that invaluable fluid has been obtained in different parts of the county.

WATER-BEARING STRATA IN THE VICINITY OF THE SACRAMENTO RIVER.

Up the Sacramento as far as Knight's Landing the surface strata on both sides of the river resemble one another, but below a depth of from twelve to forty feet the formation on this side appears to be more clayey and shows less quicksand. A short distance westward from Washington the "tule" lands commence; here the deposit formed from "tule" roots and mud is from five feet to ten feet in thickness. When the tule lands are not flooded a bitter water is obtained at a depth of a few feet. Beneath the "tule" roots is a tough clay, intercalated with irregular strata of sand and fine gravel, which extend down to a depth of one hundred and fifty or two hundred feet. Below a depth of fifty feet the clay, which at first is usually of a reddish color, becomes darker and passes into a blue clay at a depth of about one hundred to one hundred and fifty feet. The first water, which is unfit for any use, is cased off. At a depth of one hundred and fifty to two hundred feet good water is obtained in a stratum of sand.

The following tabulated record of wells which were bored at points along the strip of sediment land before referred to, bordering the Sacramento River between Washington and Knight's Landing, is not without interest:

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RECORD OF WELL ON CASTLEMAN'S RANCH, EIGHT MILES UP FROM WASHINGTON.

Character of Strata.	Thickness of Strata, in feet.
Soil	12
Yellow clay	30
Quicksand, with water	20
Blue clay	7
Yellow clay	8
Beneath the clay was a yellow sand, containing a good supply of water.	

RECORD OF WELL ON PHLEIGER AND PALMER RANCH, EIGHT AND ONE HALF MILES UP FROM WASHINGTON.

Character of Strata.	Thickness of Strata, in feet.
Black loam	17
Surface water.	
Yellow clay	10
Black clay	50
Clean gravel, with good water; temperature, 58 degrees Fahrenheit.	

RECORD OF WELL BORED ON CLARK AND CAVE RANCH, EIGHTEEN MILES UP FROM WASHINGTON.

Character of Strata.	Thickness of Strata, in feet.
Sandy sediment soil	1
Black alluvial soil	2
Sandy soil	37
Bluish clay	20
Sand passing into gravel	20
This stratum yielded an abundance of good water.	

RECORD OF WELLS BORED ON HOOVEN RANCH, ABOUT TWENTY MILES UP THE RIVER FROM WASHINGTON.

Character of Strata.	Thickness of Strata, in feet.
Loam	17
Blue clay (in this stratum a sycamore log was bored through)	60
Beneath the blue clay was a gravel which yielded a good supply of water; temperature, 58 degrees Fahrenheit.	

From the foregoing, it appears that the surface water is struck along the western bank of the Sacramento River somewhere between the depth of twelve and twenty feet, but the water-bearing strata principally depended on lie at a depth of from thirty-five feet in the neighborhood of Washington, to from seventy-five to ninety feet farther up the river toward Knight's Landing. At Knight's Landing the surface soil is a clayey loam, and the first water stands at a depth of from sixteen to eighteen feet below the surface. The formation corresponds pretty much to that already observed along the river bank. In boring throughout the tule lands lying to the north of Knight's Landing, commencing at a point about half a mile from the river, a dark-colored clay is penetrated for about sixty to one hundred feet. Any water found there is said to be unfit for use, it being either alkaline or sulphurous. Mussel shells are said to be frequently found in this clay.

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Character of Strata.	Thickness of Strata, in feet.
Sandy loam	20
Surface water was struck at a depth of seven feet.	
Coarse gravel; this afforded a good supply of water of a temperature of 60 degrees Fahrenheit	30
Hard yellow clay, varying to bluish and grayish clay; this stratum contained numerous limestone concretions	180
Coarse gravel penetrated	3

This gravel yielded an abundant supply of water, which, upon completion of the well, stood within seven feet of the surface; the temperature of the water was 62 degrees Fahrenheit.

At the Blowers Ranch, in the southeastern outskirts of Woodland, a well was bored to a depth of one hundred and forty-three feet, and the following formations noted:

Character of Strata.	Thickness of Strata, in feet.
Sandy loam	8
Sand and gravel	4
Coarse gravel, with much water	12
Stiff clay, passing into clay and gravel	69
Stiff clay	42
Cemented gravel, passing into gravel containing an abundant supply of water	8

This well yielded about six hundred gallons per minute, but when a centrifugal pump was used the suction of the water was so great that it caused sand and gravel to rise in the well and partially choke the pipe.

About one and a half miles southeast of Woodland, on the Briggs estate, the following formations were noted:

Character of Strata.	Thickness of Strata, in feet.
Soil	10
Surface water.	
Yellow clay	60
Gravel, with good supply of water	4
Yellow clay	30

Beneath the yellow clay blue clay was penetrated one hundred and forty-six feet.

WELLS IN SOUTHERN PORTION OF YOLO COUNTY.

Several years ago borings were made in the vicinity of the "sink" of Putah Creek in the hopes of obtaining flowing water. Three wells were bored to a depth of four hundred feet and one to a depth of six hundred feet. No flow of water was obtained, but at the depth of about a hundred feet a fairly good water was found; below that depth the water was impregnated with "alkali" and "sulphur." A few miles eastward from Davisville the following formations have been found:

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Character of Strata.	Thickness of Strata, in feet.
Surface soil, clay loam, and adobe, with very hard water	10 to 15
Tough yellow clay	60 to 200
Coarse, dark-colored sand and gravel, containing good water.	

The yellow clay was frequently traversed by streaks of sand containing "alkali water." Around Davisville the first water is struck at a depth of about twenty feet, but it is very hard. Fairly good water is, however, obtained from gravel at a depth of from forty to seventy-five feet.

The formation penetrated by wells at Davisville and vicinity is as follows:

Character of Strata.	Thickness of Strata, in feet.
Sandy and clayey loam	10 to 15
Tough yellow clay	40 to 75
Sand	1 to 2

Beneath the sand is a gravel yielding a good supply of water. A rotary pump throwing two thousand gallons per hour did not exhaust the water from a six-inch well which penetrated this gravel for a few feet.

Sometimes the yellow clay has been passed through to the depth of ninety-five feet from the surface without striking any gravel; but strata of porous clay were encountered which yielded sufficient water for domestic use. The yellow clay is often found to contain numerous concretions; those observed by the writer were calcareous.

Close to the Putah Creek the formation resembles that around Davisville, except that the water-bearing strata lie deeper, and quicksand is frequently very troublesome.

A well was bored in an early day on the old Davis, now the Brannigan Ranch, about three miles northwest from Davisville, to a depth, it is said, of five hundred feet, in the hopes of obtaining flowing water. No flow of water was obtained, but a good supply for farm purposes is pumped from the well. It is the softest water in the vicinity. A few feet away a well has been bored to a depth of forty-eight feet; the water is cooler, but very hard.

About three miles east of Cacheville on the Eustis Ranch, two beds of water-bearing gravel are cut within seventy feet of the surface. The strata observed when boring on that ranch were as follows:

Character of Strata.	Thickness of Strata, in feet.
Soil, clayey loam	8
Gravel, with water	20
Yellow clay	26
Sandy clay	10

Beneath the sandy clay was a stratum of gravel yielding a good supply of water.

In the neighborhood of Cacheville, the first water is generally struck at a depth of about twenty-five feet, the strata penetrated being as follows:

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Character of Strata.	Thickness of Strata, in feet.
Clay or sandy loam	10 to 20
Hard, tough clay, alternating with thin strata of sand	15 to 50

It is only occasionally that this stratum exceeds a depth of twenty feet; the tough clay overlies a stratum of gravel with plenty of water.

On the Brag Ranch, about three miles northeast from Plainsville, the following formation was observed in boring:

Character of Strata.	Thickness of Strata, in feet.
Soil	12
Gravel	15
Hard clayey cement	22

Beneath the cement was a coarse gravel with plenty of good water.

WELLS IN THE NORTHERN PORTION OF THE COUNTY.

On the Garoutte Ranch, about seven miles northeast from Woodland, and one and one half miles from the Sacramento River, a well was bored through the following formations:

Character of Strata.	Thickness of Strata, in feet.
Adobe soil	6
Yellow clay	4
Sand and gravel	3
This stratum yielded an alkaline water.	
Yellow clay	51
Sand, yielding a good supply of water, which rose two or three feet in the pipe	2

Farther to the west the superficial strata are thicker, and the first water struck is of a fair quality. On the Laughneaur Ranch, two and one half miles west of the last mentioned well, the following formation was observed:

Character of Strata.	Thickness of Strata, in feet.
Soil	12
Yellow clay	17
Sand	2
Gravel, yielding a good supply of fairly good water.	

It would appear that in this vicinity the formation is unreliable, for, in one instance on this land, a well was bored only a few feet from where the above formation was observed without discovering any water-bearing gravel; beneath the surface soil the boring penetrated yellow clay, intercalated with quicksand down to a depth of one hundred and thirty-six feet.

Few of the wells in the immediate vicinity of Cacheville exceed a

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In the foothills to the north and west from Blacks the supply of water is uncertain, and the depth at which it can be obtained increases. Thus, at the Fairchild Ranch, the formation penetrated in boring was as follows:

Character of Strata.	Thickness of Strata, in feet.
Clayey soil	3
Blue clay	130

At the depth of sixty-five feet a small stratum of quicksand was struck which afforded a fair supply of water, but the quicksand rose with the water.

Around Dunnigans, wells are usually bored to a depth of from fifty to seventy feet. The surface soil is a clayey loam, which is on an average about twenty feet in thickness. Beneath the surface soil is a stratum of blue clay about forty feet thick, which overlies gravel containing an inexhaustible supply of water. The surface water is struck at a depth of twenty feet, but it is usually very hard.

Eastward from Dunnigans the dark clay loam passes into adobe as the "tule" lands on the borders of Sycamore Slough are approached. Sycamore Slough itself is probably an old channel of the Sacramento River, which enters Yolo from Colusa County and joins the Sacramento River near Knight's Landing.

Northeast from Dunnigans, near the county line, the surface water is struck at a depth of about twenty-five feet in sandy loam; borings have shown that this formation on the Glascock Ranch extends down to a depth of one hundred and ninety feet; at that depth a good supply of soft water was obtained; the boring terminated in a sandy clay.

In the rolling land, which commences a short distance to the west of Dunnigans, the depth of the wells increases until at the foot of the Coast Range a depth of from two hundred and fifty to three hundred feet has to be obtained. In the mountains themselves there are numerous springs of both fresh, salt, and sulphurous waters. On the Grafton Ranch, in the rolling land about seven miles west from Dunnigans, the following formation was observed in boring:

Character of Strata.	Thickness of Strata, in feet.
Surface soil	6
Yellow clay	156
Gravel, with small quantity of seepage water	20
Yellow clay	18
Sand	1
Yellow clay	30

Beneath the yellow clay was gravel that yielded a good supply of water. There is a great variation in the depth of the wells throughout these rolling hills, the depth at which a good supply of water can be obtained being governed by the elevation of the surface; whereas, the last mentioned may be taken as an example of deep wells throughout this district. The following well, which was bored in a depression at no great distance from the Grafton Ranch, may be taken as an example of the more shallow:

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Throughout the center of Yolo County, the depth at which the surface water is struck varies from eight to fifteen feet; a surface-water plane of sand and gravel, having a gradual slope to the southeast, as already mentioned, appears to extend throughout that portion of the valley land lying between Cache and Putah Creeks.

On the Wilcox Grant, about four miles northwest of Woodland, the following formation was passed through in boring:

CHARACTER OF STRATA.	Thickness of Strata, in feet.
Sandy loam	10
Coarse gravel, with cobblestones	22
Yellow clay	20
Fine sand, with good water	2
Yellow clay	20

Below the clay a gray sand was found which contained a plentiful supply of good water.

On the ranch of H. Odlum, about two and a half miles northeast of the last mentioned well, the following formation was noted:

CHARACTER OF STRATA.	Thickness of Strata, in feet.
Sandy loam	30
Yellow clay	56
Quicksand	2

Gravel, containing a good supply of water. This stratum was penetrated about six feet. The water rose about two feet in the casing.

Around Madison the soil is clayey loam and adobe, and is generally about six feet in thickness; beneath it is a stratum of gravel which is generally penetrated twenty-five or thirty feet, at which depth an immense supply of water is obtained. On the Jones Ranch, about one mile east from Madison, a well forty-five feet in diameter was dug to a depth of twenty-four feet. A boring was first made to test the formation, which showed the clay loam to be twelve feet in depth and penetrated the gravel for twenty-eight feet. The well was sunk for irrigation purposes. During the sinking the well was cleared of water by two steam pumps, each of which had a capacity of two hundred thousand gallons per hour. They formed a temporary creek which ran for a distance of ten miles.

While digging this well several iron arrowheads were found at a depth of twelve feet beneath the surface. Water is now pumped from this well by a pump which has a capacity of two hundred thousand gallons per hour. Continued use of this pump lowers the water in the well five or six feet. From this well twenty-four acres can be flooded to a depth of about one foot in two and a half days.

This well proved conclusively the connection between the water planes in the gravel it penetrates with that cut by the bed of Cache Creek which flows by the Jones Ranch on the north side, for while the two large pumps were working pools of water in holes dug in the bed of Cache Creek for watering stock, as is customary during the latter part of summer, dried up, but they refilled as soon as the pumping was dis-

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during which time it had cost only $14 for gasoline, and had furnished about two thousand gallons per day.

At the village of Madison the following formations were observed in boring:

Character of Strata.	Thickness of Strata, in feet.
Soil, clayey loam and adobe	12 to 15
Surface water, in gravel or sand and porous clay.	
Yellow clay	24 to 30
Coarse gravel	25 to 35
Stiff yellow and blue clay	70
Coarse sand gravel, with plenty of water.	

Northward from Madison across Cache Creek, throughout the district known as Hungry Hollow, the formation is practically similar to that observed on the south side of Cache Creek. Close to the creek good water can be obtained at a depth of thirty feet. The depth of the surface wells increases, however, toward the northern end of the hollow, and in the rising ground upon its eastern and western sides.

The depth of the second water-bearing stratum, after leaving the immediate neighborhood of Cache Creek, increases until a point about six miles north of Madison is reached; and thence, for some distance northward, the second water-bearing stratum is said to be struck at a less depth.

On the Gordon Grant, about two miles east and three miles north of Madison, a well was sunk in the rolling lands and the following strata were encountered:

Character of Strata.	Thickness of Strata, in feet.
Soil, clayey, gravelly loam	3
Yellow clay	50
Thin stratum of sand, yielding water	2
Yellow clays	230
Porous clay, yielding water	5

Beneath the clay was a stratum of gravel yielding a good supply of water, which rose to within twelve feet of the surface.

On the Stall Ranch, which is about twelve miles northwest from Madison, the following formations were observed in boring:

Character of Strata.	Thickness of Strata, in feet.
Clayey loam	5
Grayish clay	55
Small strata of sand, with surface water	2
Grayish clay	78

At the depth of one hundred and forty feet a stratum of gravel was struck yielding a good supply of water, which rose to within fifty feet of the surface of the ground.

Also, upon the Nast Ranch, about a mile northeast from the Stall Ranch, a good supply of water was obtained at a depth of one hundred and fifty-two feet, after penetrating a practically similar formation.

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This well was first bored to a depth of one hundred and six feet, but it ran dry.

A very interesting survey was made by one of the irrigation companies holding a water right on Cache Creek. Their survey extended up Hungry Hollow, and also a few miles to the east of Cache Creek; their object being to get the elevation and slope of the valley, and to ascertain the slope of the natural surface waters underground.

To this end they bored some fifteen wells and measured many others, in order to determine whether the surface-water plane on the north side of Cache Creek was coincident with the surface-water plane on the south side of that stream.

They also estimated the amount of water flowing in Cache Creek above Capay as compared with the amount passing over Moor's Dam, which is a little east of north from the village of Madison; by this means they approximate the accession to the waters of Cache Creek, from the portion of the surface-water plane of Hungry Hollow subtended by Cache Creek, between Capay and Moor's Dam. They commenced their observations by estimating the amount of water flowing in Cache Creek at the Schardin Ranch, at the head of Capay Valley. According to testimony this was done on September 23, 1883. The measurement was made where the creek flows over bedrock, and the amount of water was found to be three and thirty-seven hundredths cubic feet per second, weir measurement. The same day they measured the amount of water flowing over Moor's Dam, and found it to be over twenty-three cubic feet per second. They testified that at that time the creek between the two points had in some places entirely disappeared; indeed, that there was no water between Capay and Madison Bridge, a distance of about six miles. They found, however, that water stood in the bed of Cache Creek. Wherever it had been cut down to the level of the surface-water plane of the surrounding country, at such points they also, in some instances, found springs in the northern bank of the creek. As already mentioned, several wells were bored by the water company's engineers; they were principally in Hungry Hollow, and some to the south of Cache Creek; and many other wells were measured.

In Hungry Hollow they appear to have especially directed their attention to the central and eastern portions of the hollow. They found the surface water the deepest near the western foothills, about half way up the hollow, where water was struck at a depth of about eighty-eight feet. From that point, traveling in an eastern direction towards Gordon Slough, it gradually decreased to a depth of between forty feet and fifty feet in the center of the hollow, and only twenty-four feet on the borders of the slough itself. Crossing the slough and receding from it towards the east, the depth at which the surface water could be obtained increased with the distance. Descending the Gordon Slough in a southeasterly direction, the depth of the surface water decreased from twenty-four feet, as already described, to ten or twelve feet near Cache Creek. Ascending Cache Creek along its northern bank from the point where it is joined by Gordon Slough, the depth to the surface water increased from ten or twelve feet to thirty-two feet near the foothills to the north of Capay. In descending from their most northern boring to the junction of Gordon Slough and Cache Creek, a distance of about thirteen miles, they found that the difference in surface elevation was about one hundred feet. Continuing their measurements and borings upon the south side

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of Cache Creek, they found that the surface-water plane sloped toward the southeast; that it could be struck at a depth of about thirty feet near the foothills, and about ten feet at a point three or four miles southwest from Woodland, while the difference in surface elevation between the same points was between forty and fifty feet. They came to the conclusion that there was a stratum forming a surface-water plane that extended between Cache and Putah Creeks that had a dip to the southeast about one foot to one mile, while the slope of the surface was about two and one half feet to the mile.

The examination of fifty to seventy-five wells seemed to establish the fact that throughout Hungry Hollow and the country lying between Cache and Putah Creeks, the slope of the surface-water plane was uniform from northwest to southeast; that the surface-water plane from Hungry Hollow joined that between Cache and Putah Creeks, except where it was bisected by deeper portions of the channel of Cache Creek; for when the channel of Cache Creek was cut down low enough to intercept the grade line of the surface-water plane, a pool was formed, although adjacent and somewhat higher parts of the bed of the creek were dry. Another strong point they made was that in such places they sometimes found springs issuing from the northern bank of the creek.

The grade also proved the coincidence of the surface-water plane on each side of the creek, and it was by no means an unreasonable deduction, that a large portion of the increment of water observed, between that measured at the head of Capay Valley and at Moor's Dam, might come from the direction of Hungry Hollow.

Two miles south of Madison, throughout the Cottonwood District, the following formations have been observed in boring:

Character of Strata.	Thickness of Strata, in feet.
Soil, clayey and sandy loam	12
Surface water.	
Yellowish clay	30

Beneath the clay is a gravel yielding a good supply of water.

On the Russel Ranch, in the Buckeye District, seven miles south of Madison, the formations observed in boring were as follows:

Character of Strata.	Thickness of Strata, in feet.
Soil, sandy loam and clayey loam	25 to 30
Surface water (hard).	
Yellow clay	60

Beneath the clay a good supply of water was obtained in a stratum of sand.

Around Winters most of the wells are dug, on account of the heavy beds of cobblestones, which obstruct the boring. In digging, the formations were as follows:

Character of Strata.	Thickness of Strata, in feet.
Soil and sandy loam	18 to 40
Gravel, cobblestones, with hard surface water	2 to 4

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Porous clay with cobblestones; this stratum is usually penetrated a few feet and yields a good supply of water.

FLOWING WELLS.

There are several flowing and intermittent wells in Yolo County situated a few miles northeast from Woodland, toward the sink of Cache Creek.

Upon the Coyle Ranch, about one and one half miles northeast from the town of Woodland, a seven-inch well was bored to the depth of two hundred and ninety-five feet, and from it a flow of water is obtained. The formations penetrated were as follows:

Character of Strata.	Thickness of Strata, in feet.
Sandy and clayey loam	12
Gravel containing water	10
Yellow clay alternating with strata of gravel, the clay strata being ten feet to twenty feet, and the gravel four to five feet	273

At the depth of two hundred and ninety-five feet, a large bed of coarse gravel was penetrated; water rose to within eighteen inches of the surface, and the next winter the well commenced to flow.

About four miles east of the above mentioned well, also upon the Coyle Ranch, there is a greater flow from a five-inch well, which is only about one hundred and fifty feet deep, and shows the following formations:

Character of Strata.	Thickness of Strata, in feet.
Sediment soil, with surface water	30
Yellow clay	50
Porous clay, interstratified with sand	70

The porous clay seemed to contain as much water as the sand; at one hundred and forty feet the sand was a quicksand; at one hundred and fifty feet flowing water was obtained in coarse sand and "joint clay." This well flows all the year round.

Flowing water was also obtained in a well bored on the Nelson Ranch, about three and a half miles northeast of Woodland; it is a seven-inch well, and the following strata were observed in boring it:

Character of Strata.	Thickness of Strata, in feet.
Sandy loam	12
Yellow clay	158
Gravel	12
Yellow clay	18
Quicksand	5
Yellow clay	20

The quicksand, which was struck at two hundred feet, broke into the well while operations were suspended for the night, and the well borers found in the morning that the casing was filled with it to within

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one hundred and twenty feet from the top of the well. While pumping out the quicksand, the casing would fill with water previous to each removal of the sand pump; this prevented the quicksand rising in the partial vacuum caused by the operation. At two hundred and twelve feet the water came nearly to the top of the well and at two hundred and fifty feet it flowed from a pipe six inches above the surface of the ground. The casing was then perforated at two hundred and twelve feet, and the water immediately sank about eighteen inches. This well only flows during the winter months.

Unless it is certain that flowing water has been cased off, it is always a hazardous operation to pierce the casing above the level of the stratum yielding the flowing water; for, if a connection is opened into any other water plane in which the hydrostatic pressure is less than that sufficient to overcome the weight of the column of water between the point at which the casing is pierced and the top of the well, the strength of the flow will be diminished, or perhaps, as in this case, the flow will entirely cease. There is also danger from quicksand unless the flow from the bottom of the well is a strong one.

On the Dinsdale Ranch, about three miles east from Woodland, there is a well which flows through the greater portion of the year. There is another similar well about three fourths of a mile east of Knight's Landing. Neither of these wells are of great depth.

Also, on the H. P. Merritt Ranch, about two miles northeast of Woodland, and three miles south of Cache Creek, a well has been bored one hundred and seventy-six feet, which flows during the winter season. The writer was informed of other places in the vicinity where wells less than two hundred feet deep had the water near the surface during the summer and flowed during the winter months.

GOLD.

Placer mining has been carried on in a small way along the foot of the Coast Range; and quartz, that by assay showed a small amount of gold and silver, is said to have been discovered farther back in the mountains. In an early day a mining camp for some time maintained a struggling existence near the mouth of Putah Creek. Some sluicing is also occasionally done in the foothills to the west of the Orleans Vineyard, near Capay, during the winter when water is plentiful, and it is said that as much as $2 per day have been made to the man.

COAL.

Prospecting for coal has been undertaken in Cache Creek Cañon, and some work has been done there on several outcrops of the coal measures. In a tunnel on the ranch of Lowe & Scott, at the headwaters of Cottonwood Creek, several small veins of coal were struck. In cutting a road from Capay Valley to Lower Lake, in Lake County, strata of shale were exposed containing numerous small seams of coal. A similar formation extends throughout a large district of Government land lying between Putah and Cache Creeks.

A vein of coal about two and one half inches in thickness was struck while sinking a well at Park's Toll House, on the Napa County line. The coal formation also extends northward towards Colusa County.

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BUILDING STONE.

The only quarry that is worked to any extent in Yolo County is situated at the Devil's Gate, in Putah Cañon, about nine miles west of Winters, on the north side of Putah Creek. The formation in which the quarry has been opened appears to extend from a southeasterly to a northwesterly direction. The stone is a compact sandstone of various shades of blue and gray; it is of smooth grain, and occasionally shows particles of carbonaceous matter. Where the rock has been quarried, near the road at Devil's Gate, it appears to be free from pebbles. It splits with a true fracture, and slabs fourteen feet by sixteen inches by ten inches have frequently been taken out. This stone has been used for many years for cemetery and building work, and it appears to wear well. It is said that it was originally intended to build the Capitol at Sacramento of this stone. The strata exposed at the Devil's Gate quarry are, many of them, twelve or fifteen feet in thickness, and dip to the northeast at an angle of about 65 degrees. In the part of the cañon where the quarry is situated, the Putah Creek has cut through the upturned strata almost at right angles with the formation. In T. 8 N., R. 2 W., M. D. M., a ledge of aragonite similar to the Suisun marble is said to have been discovered.

A volcanic tuff occurs abundantly in the eastern margin of the foothills to the west of Winters, and in places affords a fair building material. It is a soft, whitish rock, which becomes hard on exposure to the air.

The residence of J. R. Wolfskill was built of this stone about twenty-five years ago, and appears to stand the weather remarkably well; several other buildings in Winters are built of similar material.

A sandstone suitable for building purposes is also said to occur on the ranch of E. Gordon, about eight miles north of the Vacaville and Clear Lake Railroad.

BRICKS.

There are three brickyards on the southeastern outskirts of Woodland, namely: The brickyards of L. F. Craft, of H. Masten, and of H. Ervin. They are all situated in close proximity to the railroad track, and the bricks are burnt in open kilns.

The Craft yard has been established about twenty years; the material used is obtained from a stratum of clay five to ten feet in thickness, which overlies a stratum of sand. The material is tempered in the bank by being sprinkled a few days before use. It is then "cut down" in the bank and conveyed to the "pug mill." Both hand and machine-made bricks are produced at this yard. The latter are made with a Kells brick machine, which has a capacity of sixteen thousand bricks every ten hours. It is run by an eighteen horse-power engine. The clay is put into a hopper, at the bottom of which semi-circular knives force it into a cylinder, whence it passes under a pressure of twenty thousand pounds through dies, from which the clay issues in solid bars of the required breadth and thickness. These bars of clay travel on a movable table, upon which they are cut by ten steel wires into the required length.

These machine-made bricks are much firmer than those which are made by hand, much less water being added to the clay; they can be

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handled with impunity from the moment they leave the machine. They are stacked up in the yard in tiers of nine bricks high to dry. The hand-made bricks have to be placed in the yard in rows that are only one brick high, and allowed to dry three days before they can be handled. The pressed brick require seven or eight days to burn, and the hand-made ones eight or nine. The capacity of the yard with the present plant is sixteen thousand bricks per diem.

About one cord of willow and cottonwood is used to every three thousand hand-made bricks. About seven men are required to supply and tend the Kells machine; about fourteen men are employed about the yard altogether. Most of these bricks are disposed of in the local market at about $8 per thousand for hand-made and $12 for machine-made bricks.

The Masten yard, established four or five years ago, uses the same clay stratum as the former. The clay and sand are mixed in the proportion of one to two; here the bricks are all hand-made. The output of this yard is about five hundred thousand bricks per annum, about half of which go to the neighboring towns.

The Ervin was the last established and corresponds in material, method, and output with the Masten.

At Winters a brickyard for hand-made bricks is owned by J. Cradwick. The material, a clayey loam with clay subsoil, is procured on the north side of Putah Creek, and averages about twenty feet thick. A little creek sand is mixed in during the making. The bricks are burnt in open kilns. Oak and pine wood are principally used as fuel, fifty cords being required in burning one hundred thousand bricks.

Bricks have also been made in the vicinity of Capay. The material used was a clayey loam, which contained sufficient sand to prevent cracking.

IRRIGATION.

Although three water rights have been located on Cache Creek, there is only one which is in active operation.

The Moon irrigation system is private property. The water right was located in 1857. The main ditch extends for about twelve miles, and the lateral ditches for about forty-eight miles.

This system irrigates a territory which, taking Woodland as a center, may, roughly speaking, be said to extend in a westerly direction about six miles; in a northerly direction, three miles, and about two and a half miles to the south; finally mingling its waters with those of the tule lands in the eastern part of the county. The dimensions of the main ditch are as follows: breadth at the bottom, sixteen feet; at the top, forty to sixty feet, with a depth from six feet to ten feet. This ditch diverts about fifteen cubic feet of water per second from Cache Creek, at a point about eight miles west of Woodland. The dam belonging to this system is built of planks and piling. The fall of the main ditch is irregular, but averages, perhaps, four feet to the mile.

The Capay Ditch Company was incorporated in April, 1879, and bought out the right, title, and interest of the Cottonwood Ditch Company. The system and water right consisted of about fifteen miles of main ditch. The ditch was sixteen feet wide at the bottom, and twenty-four feet at the top, having a depth of about three feet. The territory that this system would reach lies between Cache and Putah Creeks, commencing at the foot of the Coast Range. This company claims

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Name of nearest town	Smartsville.
Direction and distance from town	One half mile northeast.
Distance from nearest railroad station	17 miles.
Cost of freight from railroad to mine	75 cents per hundred.
Cost of freight from San Francisco to railroad station	26 cents per hundred.
Size of claim	67.7 acres.
Class of deposit	Ancient river.
Capping	Volcanic and soil.
Depth of deposit, volcanic capping	10 feet.
Depth of deposit, soil	15 feet.
Depth of deposit, gravel	250 feet.
Course of channel	Northwest and southeast.
Elevation of top of deposit above sea level	650 feet.
Elevation of bed of nearest ravine	Timbuctoo Ravine, 250 feet.
Class of bedrock	Blue trap rock.
Worked by tunnel or shaft	Tunnel.
Cost of tunnel, including track	$5 per foot.
Cost of gangways	$5 per foot.
How ventilated	By shaft.
Cost of air shaft	$5 per foot.
Kind of drill used	Hand drill.
Powder used	Giant No. 2.
Amount per foot of tunnel	2 pounds.
Amount per foot of gangway	2 pounds.
Gravel	Cemented.
Gold recovered	By washing and arrastra.
Width of channel drifts	6 feet.
Depth of gravel drifts	7 feet.
Percentage of cobbles and bowlders	65 per cent.
Number of carloads extracted per shift	60.
Number of shifts per day	2.
Number of men per shift	20.
Yield of gold per carload of gravel	$1 25.
Weight of carload of gravel	1,200 pounds.
Value and fineness of gold	$19 25; 930 fine.
Cost of recovery of gold per carload, mining	$1.
Timbering	75 cents.
Washing	50 cents.
Kind of mill	Three arrastras.
Capacity of mill, tons in twenty-four hours	120 carloads—77 tons.
Quantity of water used for washing	75 miner's inches.
Timber, kind of	Spruce and pine.
Source of supply	Nevada County.
Distance to supply	18 to 20 miles.
Cost of, as measured	4 cents per foot.
Kind of lumber	Pine.
Source of supply	Nevada County.
Distance to supply	18 to 20 miles.
Cost of, as measured	$20 per thousand.
Power used	Water.
Source of supply	South Yuba.
Cost of water	Owned by company.
Length of ditch	40 miles.
Head of water	120 feet.
Length of water season	All the year.
Number of men in mine	32.
Number of men in mill	6.
Nationality	Caucasian.
Wages, in mine	$2 10.
Wages, in mill	$2 10.
Length of channel worked	345 feet.

WHEATON & COMPANY MINE,

Adjoining the last mentioned mine and also belonging formerly to the Smartsville hydraulic mines, has been likewise converted into a drift mine.

When located	**1854.**
Size of claim	**1,000 feet by 600 feet; is wedge-shaped.**
Class of deposit	**Ancient Pliocene river channel.**
Capping	**Soil.**
Depth of deposit, soil capping	**150 feet.**

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a tunnel, and an eight-stamp mill and hoisting gear. The main shaft is sunk on the vein to a depth of one hundred and seventy-five feet. The tunnel runs in from the surface for a distance of three hundred feet and was purposed to act as an adit. The mill and hoisting gear were run by a forty-foot overshot wheel. The country rock is a chloritic slate through which the five feet of quartz can be traced. It is said to assay $11 per ton in gold; the whole concern was idle, but preparations were being made to give it an early start again.

BROWN'S VALLEY.

A good many years ago this was quite a lively mining camp and several mines were opened here to quite a depth and some large mills were run. It is stated that over $2,000,000 have been taken out of this camp. The principal mines at that date were the Dannebrog, Pennsylvania, and the Jefferson, besides some placer claims that have yielded very large pieces of gold. The camp is situated in Sec. 16, T. 16 N., R. 5 E., M. D. M., on the borders of the foothills, and had at one time sixty-six stamps dropping.

THE DANNEBROG,

Situated at the north of the village, is a full claim held by United States patent. The vein incased in trap courses north 65 degrees east. Three pay shoots are known to exist and have been worked. They are narrow, pitching to the east at an angle of 45 degrees. No. 1 shoot is one hundred and twenty-five feet long, No. 2 eighty feet, and No. 3 ninety feet. On No. 1 a shaft has been sunk outside of the vein to a depth of six hundred feet, and seven tunnels driven across to the vein. No. 2 had a windlass shaft on it. The ore, although containing iron and copper sulphurets, was free-milling; the concentrated sulphurets are said to have assayed as high as $700 per ton. The foot wall was partly decomposed. Nothing is being done on this property at the present time. The altitude is about two hundred and fifty feet, according to the aneroid. The Dannebrog had an eight-stamp mill and hoisting works.

THE HIBBERT & BURRIS

Is the only mine that has been worked of late, and it is idle at present, awaiting the coming canal, without which they have no water with which to run their machinery. They have an incline shaft sunk on the vein a distance of one hundred feet at an angle of 45 degrees from where they have started to drift on their ore, of which they have quite a pile out waiting to be milled; it will average $20 per ton. This mine adjoins the Dannebrog, close to town.

THE CLEVELAND PLACER MINE

Covers one hundred and sixty acres, partly on the town site of Brown's Valley. The gravel is from eighteen inches to six feet deep, mostly free, but cemented in part. There is a soil capping of about one foot. In the ten inches next the bedrock the gold is very coarse. The bedrock here is granite, with trap, and in the latter stringers of quartz. Snow

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Name of drill used	Hand drill.
Kind of powder used	Giant No. 2.
Quantity of powder used	90 pounds per annum.
Cost of mining per ton of ore	About 75 cents.
Distance from mine to timber	2 miles.
Source of timber	Bought from outside parties.
Cost of timber	4 cents per foot.
Distance from mine to lumber	1½ miles.
Source of lumber	Crane Brothers' mill.
Cost of lumber	$14 per thousand.
Length of ditch	3 miles.
Means of transporting ore to works	Dump direct into ore bin.
Character of ore	Gold quartz, with large percentage of sulphurets.
Method of treating ore	Amalgamation and concentration.
Description of works	3½-foot Huntington mill run by Pelton wheel.
Quantity of water used in Huntington	15 miner's inches.
Screens	Slot-punched No. 7.
Plates, size of aprons	36 inches by 88 inches, double.
Copper or silvered	Copper.
Inclination, inches to the foot	One half inch and three quarters inch.
Kind of feeder	Challenge ore feeder.
Name of concentrator	Endshake shaking tables.
Number of concentrators	3.
Sulphurets	1 per cent.
Value of per ton in gold	$175.
Value of per ton in silver	2 ounces.
Method of saving	On shaking tables.
Method of treatment	Shipped to Selby & Co.
Cost of treating per ton	$20.
Percentage of value saved in working	91 per cent.
Number of men employed in mine	6.
Number of men employed in mill	2.
Nationality	Caucasian.
Average wages paid per day in mine	$2 50.
Average wages paid per day in mill	$2 50.
Water or steam power	Water.
Cost of water	10 cents per inch, from South Feather River Company's Ditch.
Developments made in the year	600 feet of adit run.
Proposed improvements	A tunnel 160 feet lower, and ten-stamp mill.
Faults in mine	In north drift, second level, the vein has dropped from hanging to foot wall.
Describe ventilation	Water blast.

At the present sixty miner's inches of water are used on all the wheels, under a pressure of one hundred and fifty feet. Only forty-five inches will be required when the tunnel gets in, as it will relieve the pump.

Between the mine and town is a strata of clay running nearly north and south, indicating on the surface the contact; and to the west of town the granite comes in on the other side of the trap. In this granite belt, which extends towards Hansonville a distance of several miles, is a mine lying idle that belongs to eastern parties from which extremely rich quartz has been taken.

Two miles west of north from Brownsville, in the granite, is a mine being worked in a small way, the ore being crushed in an eight-foot arrastra, the owner doing most of the work by himself. It is a full claim, known as the

JOHNSON MINE,

Situated in the Hansonville Mining District, at an elevation of one thousand nine hundred feet; the vein courses north of east, dips northwesterly at about 45 degrees, and has an average width of three feet. An incline shaft sixty feet deep has been sunk on the vein and levels started on the vein in both directions, sixty feet and forty feet long. The shaft is eight feet by four feet in the clear. The proprietor breaks down his ore, then hires a man to help him hoist, and then runs the hoisted ore

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through the arrastra himself. The quartz is of the same nature and grade as in the Clarke Mine, and the ore after leaving the arrastra passes over similar shaking tables as at the Clarke Mine. The arrastra is run by a twenty-foot overshot waterwheel with forty inches of water, the water costing $2 per day. The owner proposes to run a tunnel he has started to the ledge, which will be cut at one hundred feet depth, also to erect a five-stamp mill.

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LEAD SMELTING.

By F. C. von Petersdorff, E.M., Assistant in the Field.

DISTRIBUTION OF LEAD ORES.

The occurrence of lead ores is not restricted to any particular geological formation or age, but it appears that the period of their formation has had a considerable influence upon the amount of silver contained in them, as lead ores in veins usually carry a larger percentage of silver than those that occur in beds or as ingredients of the ores of other metals. Of the numerous chemical combinations into which lead enters, the sulphide, or galena, is the most important one, as it occurs in great abundance, and nearly always contains silver.

The occurrence of absolutely pure galena (PbS), consisting of 86.57 per cent of lead and 13.43 per cent of sulphur, is extremely rare.

Next in importance is the carbonate ($PbCO_3$), containing, when pure, 77.52 per cent of lead.

It is a secondary formation derived from galena by atmospheric influences, and is frequently found forming a layer on top of a galena lode. It also occurs in deposits of considerable magnitude and but slightly intermixed with galena, as in Leadville, Colorado, Resting Springs, Inyo County, and Old Woman's Mountain, San Bernardino County, California.

The sulphate of lead ($PbSO_4$) is of less frequent occurrence. The largest masses of this ore have been uncovered in Australia, where it contains, on an average, 35 per cent of lead and from thirty to forty ounces of silver per ton.

Some of the most important lead mining districts in Europe are Linares and Carthagena, in Spain; the Puy de Dôme country and the Bretagne, in France; Silesia, the Saxon Erzgebirge, the Harz, and parts of Rhenish Prussia, in Germany; Carinthia, especially Bleiberg, in Austria, and Cumberland, Derbyshire, and Cornwall, in England.

Very productive deposits have also been found in parts of Siberia, the Ural, and Caucasus, which are owned and worked almost exclusively by the Russian Government. In the Transvaal, Cape Colony, and other parts of South Africa, the mining industry has recently received a considerable impulse by the discovery of large gold, silver, and lead deposits, which are at present being developed. The principal lead-producing districts in the United States are located in the Rocky Mountains and parts of the Upper Mississippi Valley.

THE EXTRACTION OF LEAD FROM ITS ORES.

In choosing a process for the extraction of lead from its ores, the following are the chief points to be considered:

1. The composition and yield of the ore.
2. The character of the gangue or vein stuff.

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3. The influence foreign admixtures in the ore may exert during the various stages of the operation.
4. The material available for fluxing.
5. The quality and quantity of fuel obtainable.

INFLUENCE OF FOREIGN SUBSTANCES.

Of foreign substances contained in lead ores, silver is the most frequent and important one. All lead ores contain silver, though not always in sufficient quantities to make its extraction profitable. They are consequently described as "argentiferous" or "non-argentiferous," according to whether they contain silver in sufficient quantities to justify its extraction or the reverse.

The influence of silver during the several smelting operations is rather favorable, while that of most other admixtures is more or less injurious. The one most frequently met with is zincblende. It renders the ore difficult of fusion, and aids in the formation of sulphurous slags, which retain lead, silver, and other valuable metals. Compounds of arsenic and antimony have a tendency to facilitate the formation of metallic fumes, and consequently cause loss of lead by volatilization. Iron and copper pyrites, if present in large quantities, are harmful and have to be removed by mechanical separation or roasting. The influence of earthy substances mixed with the ore depends upon their character, whether basic or acid, as they are used in the formation of slag. Silica is detrimental in the reverberatory process. Fuel has an influence upon the election of a process, as in districts where coal, coke, or charcoal is abundant blast or reverberatory furnaces may be employed, while in districts where this is not the case, and only wood or peat is obtainable, ore hearths or hearth furnaces may be used. The substances required for fluxing vary with the composition of the gangue, but, in general, some siliceous material, as sand or quartz, some ferruginous material, and lime will be wanted.

ORE DRESSING.

The first step in extracting valuable metals from their ores, is the removal of any impurities mixed with them, and at the same time to concentrate the ore to the economical limit. This limit varies with the composition and yield of the ore, as poor argentiferous lead ores will bear a higher degree of concentration than richer ones, the loss in dressing being much larger in the latter than in the former. This is especially the case when the silver contained in the ore occurs in form of a chemical combination of less specific gravity than the lead associated with it.

MECHANICAL SEPARATION.

The different constituents of an ore are usually obtained by sorting and sizing. Sorting is separation according to gravity; sizing, the same according to volume. Sorting is done either with the assistance of a current of air or of water; the method of dressing employed is accordingly described as "dry" or "wet." The latter is employed in a great majority of cases.

A description of the dressing operation employed at Clausthal, in the

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screens, settling boxes, jigs of all classes, stamps, batteries, buddles, tables, etc.; it also drives several turbines and one overshot wheel before it finds rest in the slime pits on the lowest level. As the water supply varies with the seasons, it sometimes happens that all the water available is necessary for the dressing operations. In this case, the water used for driving machinery is replaced by steam, of which there is a sufficient reserve at disposal.

Under ground the ore is separated from the absolutely barren gangue and wall rock, when it is loaded into boxes and shipped as described above. After arriving on the surface, it begins its course of treatment in the second story of the breaker house, where it is dumped on bar grates, which separate it into two classes, above and below sixty-four millimeters. The fine stuff drops through the grates into a revolving screen, where it is screened *wet.*

The coarser particles remaining on the grates are pushed down an incline into the feeder of a Blake crusher, by which it is broken up to the required size of sixty-four millimeters and under, and also falls into a revolving screen similar to the first one, where it is screened *dry.*

These screens divide the ore into two sizes; above and below thirty-two millimeters. All parts below thirty-two millimeters pass through the screens, while the larger size is ejected at the end of the drum, from where it is taken to the picking houses. The ore from the breaker screens is kept separate from that from the grate screens throughout these operations.

The products of the first picking are the following:

1. Crushing ore containing coarse particles of galena.
2. Stamping ore containing finely disseminated grains of galena.
3. Copper pyrites.
4. Iron pyrites.
5. Zincblende.
6. Marcasite.
7. Barren gangue and wall rock.

Of these the pyrites and marcasite are turned over to copper and iron smelting establishments, also belonging to the Government and located in the neighborhood, while the zincblende is disposed of in open market.

The now partly purified ore, being in size thirty-two millimeters and under, descends to the coarse separating house on the fourth level, where it is parted in the wet way into eight sizes; of which the largest size, consisting of particles over 17.78 millimeters, is once more picked over in the second picking house on the same floor, when the same products are obtained as in the first picking.

The other sizes resulting from the coarse drums are:

17.78 millimeters.
Over 13.44 millimeters and under 17.78 millimeters.
Over 10.00 millimeters and under 13.44 millimeters.
Over 7.50 millimeters and under 10.00 millimeters.
Over 5.62 millimeters and under 7.50 millimeters.
Over 4.22 millimeters and under 5.62 millimeters.

These six sizes are next treated on coarse jiggers. The particles of ore which are smaller than four and twenty-two hundredths millimeters go through the holes of the last screen of each set and are caught in a funnel.

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The turbid water, carrying with it particles of ore under one millimeter in size, flows off to a settling box, from where the fine sands are taken to the auxiliary washing house, while the coarser sizes up to four and twenty-two hundredths millimeters are drawn off from the funnels to a series of fine sizing drums, which produce the following seven classes:

4.22 millimeters.
Over 3.16 millimeters and under 4.22 millimeters.
Over 2.37 millimeters and under 3.16 millimeters.
Over 1.78 millimeters and under 2.37 millimeters.
Over 1.33 millimeters and under 1.78 millimeters.
Over 1.00 millimeter and under 1.33 millimeters.

And material of one millimeter and smaller, which is caught in a funnel below the last screen of each series.

The same sizes are also obtained in the middle and fine crushing house where the products of coarse jigging are crushed and sized.

The sizes from four and twenty-two hundredths millimeters to one millimeter are next treated on fine jiggers. The intermediate products from these and the stamp ore resulting from the different pickings are taken to the stamp mill for further treatment.

The slime produced by the stamp battery is conducted through a classification apparatus, consisting of a number of boxes of increasing size, in which the particles are deposited according to gravity. The water flows from the last box through a settler, where it deposits its fine slimes.

The sand is drawn off from the boxes, jigged, if necessary rejigged, and buddled.

The turbid water from each set of jiggers runs through an adjoining labyrinth, having a circulation of from twenty-five to thirty meters, where the slimes carried by it in suspension are deposited into cleaning tanks outside.

The slimes in the settlers are conveyed by means of a rising stream of water to the upper one of two overlapping buddles, on which pure slime (schliech) and enriched sand is obtained. The latter is passed on to the lower buddle.

The remaining intermediate products of the sand jiggers are treated on tables, and the slimes are from time to time removed from the pits and labyrinths, and buddled.

The slimes from the settlers attached to the coarse separating and crushing houses are dressed in a similar manner and on similar apparatus in the auxiliary washing house.

It is one of the characteristics of the method adopted in these works that the jigging and sizing is carried out to the extreme limit, and that all the purified ore is obtained from the jiggers, buddles, and tables, and none by hand picking.

But little has to be said of the machinery in use, as it is in no way peculiar.

The coarse crushing rolls are set eighteen millimeters apart, and make twenty-four revolutions per minute, having a capacity of from five to seven and one half tons per hour and pair.

The middle and fine crushing rolls are set to six and two millimeters, respectively, have a capacity of from two and one half to three tons per hour and pair, and sixty revolutions per minute.

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The sizing apparatus consists of revolving screen drums made of perforated sheet iron, with the exception of those having holes of one millimeter, which are of sheet copper. Those used for washing and sizing grate smalls are conical in shape, with horizontal axes, about nine feet long and from two feet eight inches to three feet six inches in diameter, and have thirty-two millimeters perforations. Their capacity is from two and one half to three and one half tons per hour, and they make twelve revolutions per minute.

Those used for breaker smalls correspond in every respect to the ones described, except in length, which is six feet.

The screens, with perforations from seventeen and seventy-eight hundredths to four and twenty-two hundredths millimeters, have the same length as the ones first described, but vary in diameter; that of the larger ones being three feet, of the smaller ones two feet.

These drums make twelve revolutions per minute, and have a capacity of from three and one half to five and one half tons per set of three. The drums for fine sizing, that is, those having holes from three and sixteen hundredths to one millimeter, respectively, are arranged in sets of five, having about the same capacity as the ones described last. They make the same number of revolutions, and are six feet long by two feet to two feet six inches in diameter.

Continuously working jiggers are used, having stationary sieves. They receive their jigging action from the upward impulse, given by a succession of strong jets of water to the ore placed on them, produced by pistons, one of which is provided for each jigger, and placed in a compartment back of the one in which the sieve is fixed, separated on top but connecting below. The buddles are arranged in sets of three. Two are fitted on one shaft, and the third on a separate one.

The uppermost one is concave, and about nine feet ten inches in diameter; the next one convex, and twelve feet in diameter. The lowest one, on a separate shaft, is also convex and about fourteen feet nine inches in diameter.

Tables of the non-continuous Planheerd pattern and Rittinger shaking tables were in use, but are now probably replaced by more modern devices.

A description of the most recent inventions and improvements of dressing machinery for argentiferous lead ores, by Oberbergrath O. Bilharz, Superintendent of the Government Lead Smelting Works at Freiberg, Saxony, was published in the "Austrian Journal for Mining and Smelting," 1890, and later in form of a pamphlet under the title of "The Concentration of Fine Particles and Slimes in Dressing Auriferous or Siliceous Plumbiferous Ores," by O. Bilharz.

On account of the explicit description and explanation of the several improvements, and the great importance they have for the smelting industry, the article has been considered to justify translation in full. The several improvements and inventions, as illustrated in the text, have been patented by the United States Patent Office.

Mr. Bilharz writes: In dressing auriferous or siliceous plumbiferous ores in the wet way, especially such as contain their different metallic substances more or less intimately intermixed with one another or the gangue, the treatment of the fine sands and slimes forms the most difficult part of the operation, and, as a rule, also the one occasioning the greatest loss.

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the remaining pieces of mixed material being left on the belt to be dropped through a funnel into the first (coarse) crushing mill.

The particles broken up in the crusher go directly to the separation apparatus for over medium-sized grains placed under it.

From this, the grains graduated into fixed sizes flow directly on the jiggers, while the refuse of this second separation apparatus has to undergo another crushing in the second rolling mill.

By arranging the works in stories, without any intermediate transportation whatever, the gradual separation into grain sizes is continued in a similar manner, as is also the jigging conducted in connection with it, after which, generally another (fourth) crushing in the third rolling mill becomes necessary.

Not until after this occurs the last (fifth) crushing of the still remaining particles of intermixed material, or the complete pulverization of the ore in the stamp mill.

The systematical conduct of this method of gradual disintegration is facilitated considerably by arranging the works in stories; or, in other words, by placing the several implements below one another in the order in which they are to be used. The jiggers for siliceous plumbiferous ores consist of four or five separate compartments, which jig most simply on an ore-bed with a current of water. They turn out besides such pure products as galena, arsenical pyrites, iron pyrites, and blende, several intermediate products.

The latter are either such in which galena visibly predominates, or such in which it is rare or finely intermixed.

In order to avoid as much as possible any loss of lead, the first class is crushed in the second rolling mill (for over medium-sized ore) conjointly with the ore resulting from the waste jiggers.

The second category goes to the stamp mill. It is, of course, not possible to completely exclude the formation of fine sands and dust, even when crushing by means of rollers. This is especially the case when the crushing has to be extended to the application of finely set rolls. The dust, or fine sand thus unavoidably produced, contains lead, and should therefore be collected and treated separately by means of appropriate apparatus.

TREATMENT OF FINE SANDS AND SLIMES.

The further treatment of these begins with pulverizing in the stamp mill, which it is the main object of this essay to describe, at the same time calling attention to the application of several new apparatuses, which have been proved by experience to be very useful and recommendable.

To begin with, it will be found advantageous to let the turbid water, resulting from the pulverization of the ore in the stamp mill, run through separating machines having one half millimeter perforations. By these means coarser particles are kept back that may have become accidentally mixed with it by reason of cracks in the channel boxes or other mechanical imperfections. These are divided into sizes up to two millimeters, and treated on continuously working jiggers. Where space has to be saved, these may be constructed on the percussion-frame principle.

The turbid water, after being freed of its coarse and accidental admixtures, has, in most cases, to be transferred to a higher level in order to

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The classification is carried on in V-shaped launders (pointed settling boxes) to the level of which the material is raised, as stated above.

The size of this important apparatus depends upon the quantity of material to be received at a charge, while the composition and yield of ore determine the system to be chosen.

In most cases, especially as the determining factors cannot always be known beforehand, that system deserves preference which permits the adjustment of the cross-section of the launder boxes and consequently of the velocity of the current to the variable amount of heavy metallic substance in the turbid water.

Of the systems principally employed, the so called "Altenberger Stromgerinne," based upon the principle of counter currents, is the first one to be mentioned. (Rising clear water current and gradually slower-flowing turbid stream, caused by the launder boxes gradually increasing in size.) It has the single drawback of a somewhat considerable consumption of clear water.

Fig. 1 shows a cross-section of this apparatus; in Fig. 15 is given a longitudinal, and in Fig. 16 a horizontal view of it.

The difference in the surface level of the water in the launder and the exterior clear water channel shown in the cross-section regulates the intensity of the classification.

Fig. 2

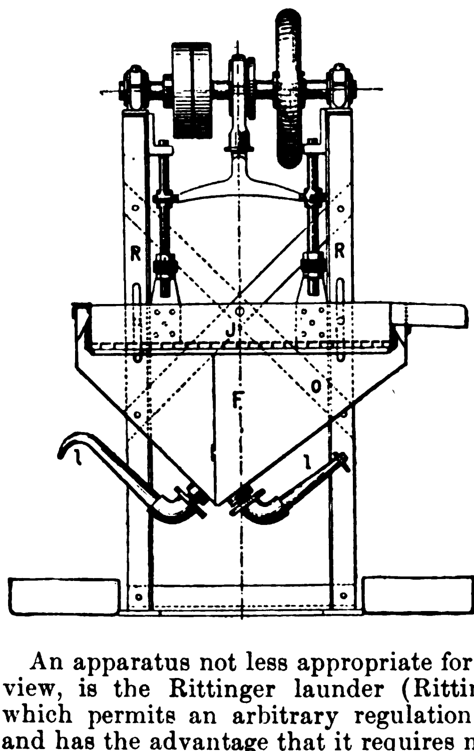
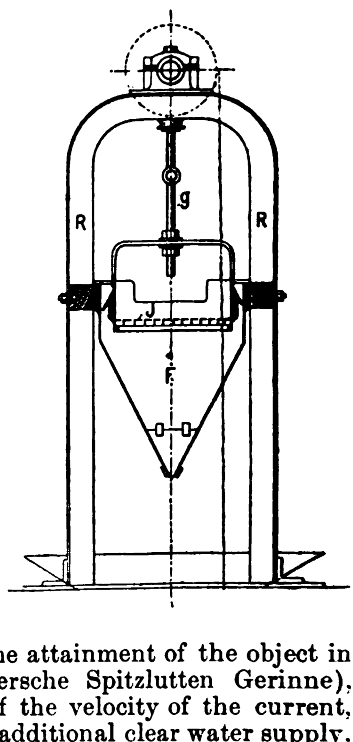


Fig. 3.



An apparatus not less appropriate for the attainment of the object in view, is the Rittinger launder (Rittingersche Spitzlutten Gerinne), which permits an arbitrary regulation of the velocity of the current, and has the advantage that it requires no additional clear water supply.

In both contrivances does the separation of the grains take place

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according to gravity; in the former, with the aid of a rising current; in the latter, of both a rising and a descending one.

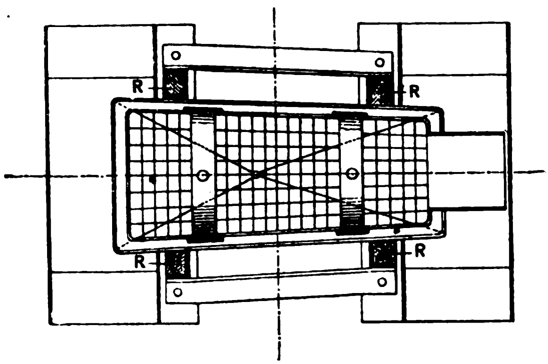
The Rittinger launder requires a greater difference in elevation between the charging and discharging points, for the reason that receiving funnels have to be placed under each section.

One as well as the other produces a graded mixture enriched in ore, as a part of the waste matter (the finest particles) is carried off by the water and deposited farther on.

The products may consequently be divided in:

Classified coarse sand, classified medium sand, classified fine sand and slimes.

Fig. 4.



The separation of the first mentioned class into its several ingredients may be done without preceding concentration.

For this operation percussion screen jiggers are very suitable, which may be put together in sets of three or more, as the occasion demands.

Representations of this apparatus will be found in Figs. 2, 3, 4, 5, 6, and 7, of which Figs. 2, 3, 4, and 7 show the single jiggers, Figs. 5 and 6 their arrangement into sets. The essential parts of this apparatus are, (1) the sieve or screen compartment *F*, suspended from the standards *R*, between which it may be raised or lowered to suit the arrangement of the several jiggers, below one another; (2) the percussion screen *I*, situated in the upper part of this box or vessel, suspended from a cross-shaft of the excenter rod, which moves in guide bars so as to cause the screen to move vertically up and down. It is tightened against the sides of the box by a leather ring.

The screen consists of perforated sheet copper or brass wire meshing, on which is placed a bedding or layer of clean ore, adjusted to the size of the material to be treated.

The screen as well as the box is widest at the receiving end, and decreases in width towards the discharging gutter.

Into the box of each jigger may be inserted a partition board, by which means two products may be obtained on a single apparatus; for this reason every jigger is provided with two discharge pipes near the bottom of the box, one of which may be closed when not needed.

The material retained by the screen collects in the lower conical part of the box *F*, and is discharged through the pipe *l*, provided with a valve.

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Fig 5.

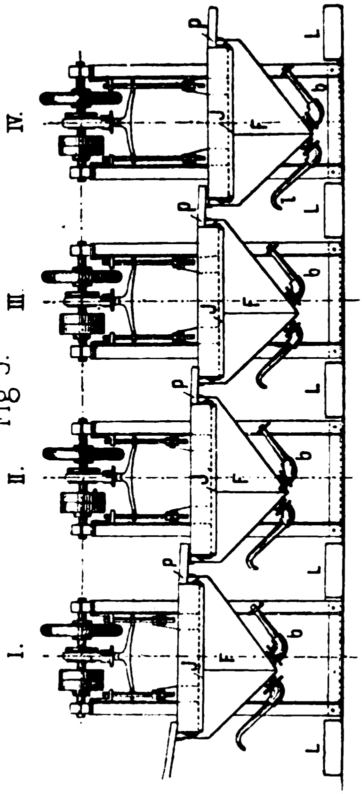
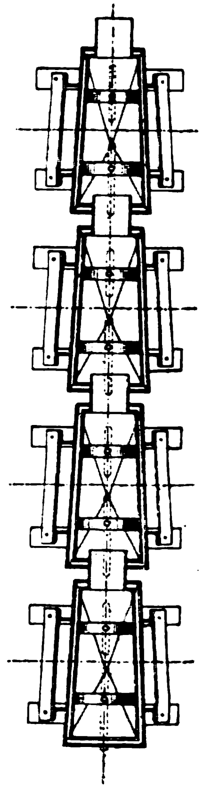


Fig 6



It must be considered a special advantage that a continuous discharge of condensed matter takes place without any considerable loss of water.

The current of clear water enters through the pipe *o*, having also a valve.

An apparatus composed of five jiggers, as required for the treatment of the coarse products of the classification launder when dressing siliceous plumbiferous ore, will produce on the—

First jigger, pure galena containing from 60 to 70 per cent of lead, and as an intermediate product, arsenide of lead.

Second jigger, rich arsenical pyrites containing 35 per cent of arsenic.

Third jigger, poorer arsenical pyrites containing from 20 to 25 per cent of arsenic.

Fourth jigger, iron pyrites.

Fifth jigger, pure waste matter and frequently blende as an intermediate product.

The intermediate products are re-treated on a reserve apparatus, commonly consisting of not more than two jiggers.

This apparatus has the advantage of being very handy, easily put together, and readily regulated without interrupting the operation. For

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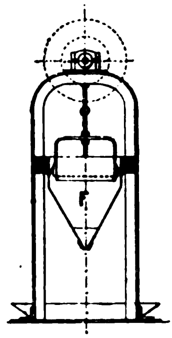
transportation it may be taken apart and again put together without requiring a foundation. This is of value when used in transmarine countries. While having the same capacity as the Harz jigger for the corresponding fine grain material, they require considerably less space, power, and clear water supply.

Fig. 7.



The medium-sized sands forming the second class of the classification apparatus are taken from the launders in three or four separate streamlets, and form generally the largest part of the classified material. Instead of taking these direct to the buddles, as formerly customary, they are advantageously previously treated in the manner of concentration described (sub. *b*).

For this purpose, the circular percussion frame jigger, represented in Figs. 8, 9, 10, and 11, is used.

The launder products are conducted to it in several streamlets and concentrated separately.

Fig. 8

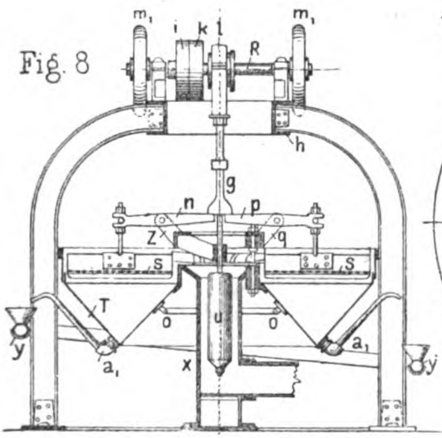
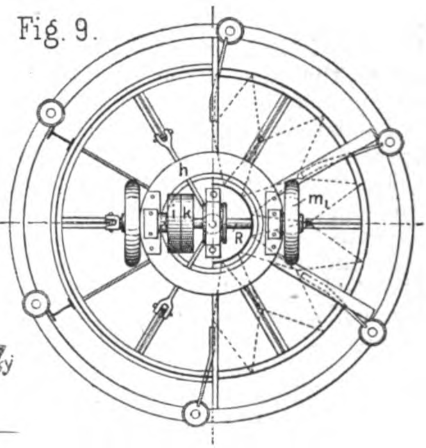


Fig. 9.



The large screen, which moves vertically up and down in a circular vessel, terminating conically at its lower end, is subdivided into six or more compartments as the occasion may require.

The screen is constructed of finely perforated sheet copper, and a bed of clean ore is spread on it, the height and grain of which is regulated to suit the size of the particles to be treated on the several compartments of the sieve.

To these correspond similar ones in the lower part of the box or vessel, which terminate like funnels in points and collect the concentrated ore, which is discharged through pipes at the lowest point in form of a turbid stream.

The mixture about to be treated is charged either at the periphery of the concentration apparatus or at the center. In the latter case a circular distributing disk *z* is provided.

The concentrated matter is retained by the bed of clean ore, while the waste is discharged through a vertical pipe in the center of the apparatus, in which is suspended a lead weight serving as a counter weight to the sieve and charge placed on it. The advantage of this apparatus over

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Fig. 10.

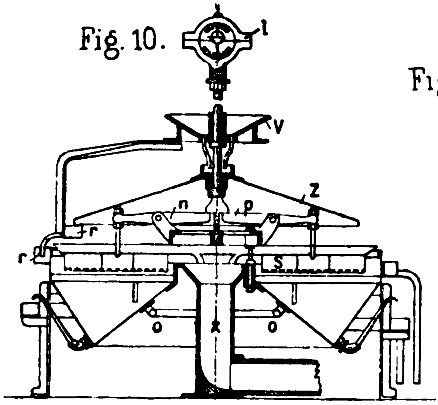
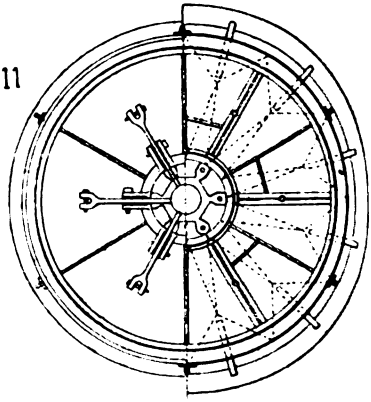


Fig 11



the otherwise similarly constructed piston stream jig consists chiefly in the fact that the different grades of classified material may be concentrated at the same time on the same apparatus, and with the same length of stroke for all. In this apparatus, as in the one described before, the edge of the screen is tightly closed against the sides of the box by means of a leather ring.

The box is always kept full of water, the unavoidable loss during the operation being constantly replaced through the feeding pipe at *o*.

The machine makes two hundred to two hundred and twenty revolutions per minute, the stroke having a length of from five to six millimeters.

No intermediate products whatever are produced by this apparatus. Its single product is the classified turbid stream, which passes the ore bed, collects in the lower compartment of the box, and is discharged in a constant stream onto buddles placed below—one for every compartment of the concentrator.

One of these concentrators having an exterior diameter of 2.20 millimeters, is sufficient for the concentration of all the medium-sized sands from the crushing of one hundred and twenty tons per day of siliceous plumbiferous ore, always provided that the graduated classification and disintegration, as outlined above, is practiced.

This amounts, under these circumstances, to a quantity of five tenths of a cubic meter of concentrated turbid water discharged per minute, or to about three hundred cubic meters per shift of ten hours.

The solid matter in a stream of this volume amounts to about twenty kilogrammes per minute, of which a little less than 30 per cent is discharged as waste, while a little over 70 per cent is produced as concentrates by the apparatus.

The concentrates resulting amount to about 12 per cent of the original raw material.

The metallic contents of the charge fed to the concentrator consist on an average of:

0.0208 per cent of silver.
5.32 per cent of lead.
2.70 per cent of arsenic.
20.40 per cent of sulphur.
10.90 per cent of zinc.

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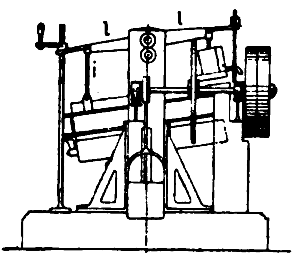
is taken up by a solid table *Q*. The frame is suspended by the beams and screens *i i* between the standards *p p*, and is movable in such a manner that any desired inclination toward the front may be given to it and the table. Over the stationary table *Q* is spread an endless plane or belt of rubber cloth, forming the working surface of the buddle.

Fig. 14.



In order to prevent the belt from sticking to the table, diagonal gutters *d* are cut in the latter, whereby water is applied which forms a thin sheet or film between the table and the plane. This is one of the recent improvements.

The impelling force which causes the plane to move is applied to one of the end rolls.

The percussion of the frame and plane is effected by means of the thumbscrew *r*, which draws the frame to one side, thereby compressing the spring *n*. When the thumb lets the frame slip, the spring causes a sudden rebound and shock of the frame against the check *t* placed on the inside of the opposite standard. It is best to regulate the gliding on of the belt or plane to 0.07 millimeter per second and the percussion to one hundred and fifty per minute.

Slipping of the plane from the inclined table is prevented by notches *m* cut into the rolls, in which catch wooden teeth on the inside of the belt. This is also one of the recent improvements.

On one end of the long side forming the back is situated a distributer and regulator of the quantity of concentrates charged on the buddle.

Clear water is conducted to the working plane by a perforated pipe (*f g*) laid diagonally across it.

The work begins with the direction of the turbid stream of concentrates onto the buddle, the inclination of the table having been adjusted to the size of the ore particles to be treated. The light waste matter separates at once from the heavier though smaller metallic particles, which adhere to the plane, and drops off the plane by the shortest way. The heavier metallic particles remain on it longer, and the specific heaviest and finest grains the longest.

The separation is most rapid and exact. In working siliceous plumbiferous ores the following substances are produced:

Pure galena.

Mixed arsenide of lead as an intermediate product.

Pure iron pyrites.

Iron pyrites mixed with blende, and when the latter is present in a mineralogically pure state, lastly blende.

The intermediate product is treated on a reserve buddle. Six buddles suffice for the treatment of ten tons of solid matter contained in the turbid stream received from the concentrator.

Two reserve buddles are provided for the intermediate products.

The buddle refuse contains on an average 0.005 per cent to 0.010 per cent of silver, 0 per cent of lead, 10 per cent to 18 per cent of sulphur, and 9 per cent to 10 per cent of zinc.

As the process is continuous in all its parts, one workman suffices for the supervision of all buddles.

The last category of products of the launders, or water classifiers, ending in a residue of fine-grained slime, is worked direct without pre-

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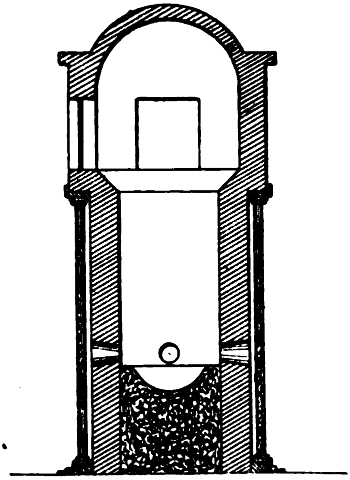
Fig. 21



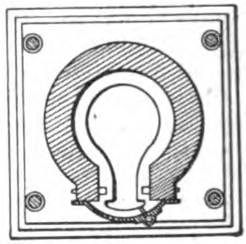


Fig. 22.

In working this furnace the charge should never contain over a third of its volume in lead. If richer ore is to be treated, it must be reduced to this proportion by the addition of poor slags.

To prevent the walls from getting too hot, and preserve the bricks from burning or melting, care has to be taken in charging to throw the fuel towards the center and the ore towards the walls. Attention has to be paid to the proper regulation of the temperature, as a too high degree of heat will cause loss of lead by volatilization. As long as the slag flows liquid and readily, the cooler the furnace is kept the better.

Some ferruginous ore is usually added at intervals during the operation.

The slag flows continuously into cast-iron wagons, from which it is dumped after having cooled down.

The advantage of this is that if at any time the furnace should run lead or matte, it can easily be recovered.

The establishment should be provided with an extensive condensing apparatus, as a considerable amount of lead volatilizes even when every precaution is taken.

THE SPANISH REVERBERATORY FURNACE.

These furnaces, extensively used in Linares, and there called "boliches," are built of rubble and clay, with a thick lining of refractory clay, of which material is also constructed the hearth bottom.

The fireplace *D* (see Figs. 23 and 24) is, without a grate, five feet six inches long by two feet two inches wide. The fuel, consisting of brushwood, is supplied at one end through the fire door *E*. The furnace is separated into two chambers *A* and *B*, connected by the flues *G*.

The first chamber *A* is used for the smelting operation, and about seven feet six inches long by six feet wide. The second chamber *B* is said to moderate the draught.

The flue *H* connects it with the chimney *C*, which is usually about thirty feet high. The hearth bottom slopes towards the front end, where

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Its chief advantage seems to be that it retains a considerable part ot the metallic dust carried through it along with the products of combustion, which may be removed through the apertures marked by dotted lines in Fig. 24 at the lateral ends of the compartment *B*.

In some parts of Spain, particularly in the district of Carthagena, a peculiar furnace is used for smelting poor carbonates of lead, which, instead of being supplied with blast by a blower or fan, is worked by a strong draught obtained by the aid of a high chimney, connected with the furnace by means of an inclined flue, while the air enters through tuyeres placed at equal distances in the opposite wall of the furnace.

This hearth is built of a mixture of clay and coke dust, and coke is used as fuel.

LEAD SMELTING IN FRANCE.

The method of treating highly siliceous ores employed in Couëron, France, consists in calcining the ore in a reverberatory furnace and smelting it in a blast furnace, using basic, silicate of iron, and lime as fluxes.

The calcination or roasting is carried on in reverberatory furnaces similar to the one represented in Figs. 35 and 36, excepting that it is filled to the level of the working doors with black slag, so as to form a flat hearth upon which the ore may be evenly spread and roasted.

THE ROASTING PROCESS.

The furnace being at a red heat, the charge, consisting of about a ton of ore, is let down into it through the hopper on top, and uniformly spread over the bottom.

The doors are closed and the temperature is raised until the ore is red hot, when they are opened and the charge thoroughly rabbled to expose new surfaces to the oxidizing influence of the heated air.

The ore must be kept from softening or clotting, as that would materially interfere with the process of desulphurization.

Consequently, whenever the temperature seems to become too high, the doors are opened until the ore has cooled off sufficiently. When the desired quantity of oxides has been formed, which will be after about six hours, the heat is increased to cause the agglomeration of the ore, which is drawn out on the floor and allowed to solidify, when it is ready for the smelting operation.

THE WATER JACKET BLAST FURNACE.

The blast furnace employed is considerably higher than the Castilian furnace (Figs. 21 and 22) described above, and differs from it in many ways. The furnace is a typical modern blast furnace, such as is used, with slight modifications, in every well appointed smelting establishment.

To prevent the loss of time, labor, and temperature occasioned by the frequent burning through of the lower portion of the furnace, the brickwork in that part has been replaced by a so called "water jacket," an annular cylinder of iron about three feet high, which is kept cool by a constant stream of cold water running through it.

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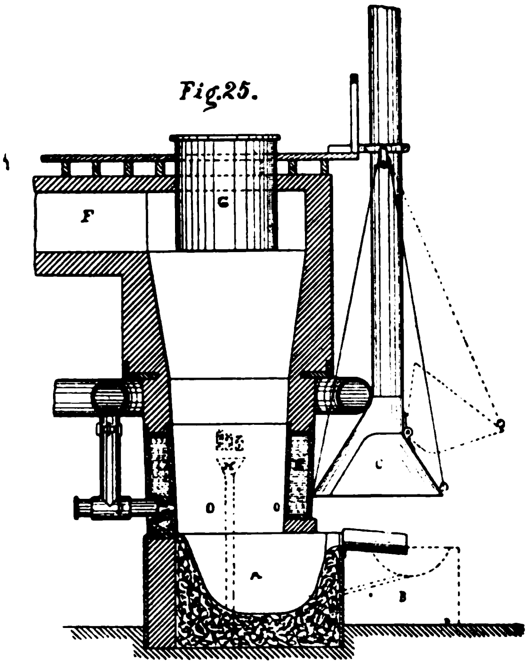
Fig. 25.



The water jacket *E* is either cast in one piece or constructed of one-half-inch boiler plate.

The position and number of the tuyeres is a matter of importance.

The usual number is five, which pierce at equal distances the lower third of the water jacket and converge towards the center of the furnace. By reducing the number of tuyeres, or placing them farther from the breast, the water would cool the interior of the jacket to such a degree as to interfere with the regular descent of the charge. The water enters through an inlet pipe at the bottom of the jacket, supplied with a valve to regulate the supply, and leaves on the opposite side near the upper edge of the jacket. The arrangement shown in dotted lines in Fig. 25 can be recommended, as the workman may readily estimate the quantity and temperature of the water as it falls from the outlet pipes *i i i* into the funnel *H* communicating with the drain, and regulate the cold water supply accordingly.

The upper part of the furnace is frequently encased in sheet iron, strongly riveted together, to strengthen it and to prevent the escape of gases.

A sheet-iron hood *c* is placed over the fore hearth, which carries off lead fumes escaping from the breast, and thus prevents them from injuriously affecting the health of the charger above.

When necessary, this hood may be pulled up, by means of a chain and pulley, so as not to interfere with the work.

The charging is done at the top, which is preferable to charging from the side or rear, as less atmospheric air enters the flue *f*. The bottom of the furnace is made of brasque and hollowed in the usual way to form a cavity for the collection of the melted lead.

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temperature is lowest, loss of lead by volatilization is considerably diminished.

The first stage of this treatment, the roasting, varies in length with the composition of the ores. Those containing much blende and pyrites require a longer period of calcination than those composed largely of carbonates and sulphates.

The object desired to be obtained in roasting is the conversion of about one half the sulphide in the ore into the sulphate or oxide, which, upon the temperature being raised, reacts on the undecomposed portion, forming metallic lead, sulphurous acid, and a residuum of slags. The process is thus divisible into two distinct parts: the roasting or oxidation, and the smelting or reduction. The operation is conducted in the following manner:

The furnace being red hot, the charge is dropped from the hopper and evenly spread over the bottom. The heat is slowly increased and the air freely admitted to cause oxidation. Whenever a crust of oxidized material has formed on the surface of the charge, a new surface is exposed by rabbling.

Cinders are used for firing in preference to coal at this stage of the operation, as they give a steadier heat, do not yield any gaseous hydrocarbons which would interfere with oxidation, and cost less.

After four or five hours the charge will be sufficiently desulphurized, when the temperature is slowly raised by adding coal to the fire, and the second stage of the operation—the smelting—is commenced.

Care has to be taken that the heat does not become too high, as that would cause loss of lead by volatilization.

To prevent fusion, lime is thrown on the mass whenever it shows a tendency to liquefy, and is thoroughly worked into it. The consumption of lime in this operation amounts to about 2 per cent of the charge. The reduced metal, which first appears in globules on the surface, drains down the slope of the hearth into the lead well. After about three hours enough will have collected to justify a tapping. The lead flows into a pot under which a fire is kept burning to keep it liquid. The dross is skimmed off and thrown back into the furnace. Coal dust, cinders, and powdered lime are mixed with the lead by stirring and the impurities once more skimmed off, when the lead is ladled into molds.

When as much lead as possible has been extracted from the charge, the heat is increased in order to completely oxidize the remaining material, but not sufficiently to fuse it.

After this object has been attained, the pot skimmings, consisting chiefly of cinders and sulphides, are thrown on the charge, when a further yield of lead is obtained. This is tapped off and the slags are raked out through a door at the back of the furnace. The entire process requires about five hours.

Before introducing the next charge, the furnace bottom has to be thoroughly examined, and, if necessary, repaired, as it is of great importance to keep it perfectly smooth and sloping evenly towards the tap-hole. About 40 per cent of coal is required. The total loss amounts to about 3.5 per cent, mainly caused by volatilization, but a considerable portion of this is recovered from the flues in which it condenses.

The slags retain about 20 per cent of the orignal amount of lead and are resmelted in a blast furnace, when the greater part of this is also recovered.

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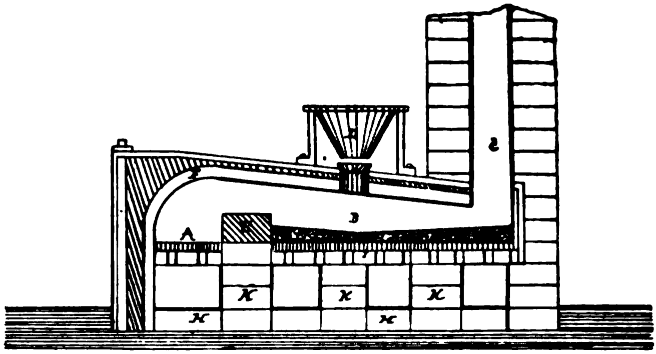

Fig 32

The charges for this process are obtained by mixing twenty hundredweight of lead slags with five hundredweight of raw ore, five hundredweight of roasted ore, and two hundredweight of quartz. The charge is introduced by means of a movable hopper *D* and uniformly spread over the bottom *B*, making the layer somewhat higher near the fire-bridge *E*.

The smelting is conducted with the exclusion of atmospheric air for about three hours, when the almost fluid mass is stirred and exposed for twenty minutes to a still higher temperature, after which the slag is drawn off. After two or three charges have been smelted in this way, a considerable amount of lead regulus, or matte, will have been reduced, which is tapped off and cast into molds and allowed to cool. It is next broken into pieces of the size of a fist, roasted, and mixed with a charge of lead ores to be smelted in a blast furnace, as represented in Fig. 44.

LEAD SMELTING IN THE HARZ.

The smelting process employed at Clausthal is applicable both to ore containing a large percentage of foreign sulphides, and to the regulus or matte produced by smelting them.

The ore is received either directly from the mines in lumps or from the dressing works in form of slimes. The latter is sufficiently purified by mechanical operations, but the lump ore has to be roasted before smelting. This is done in heaps, instead of in reverberatories, as described before.

The roasting is conducted as follows: The ore is piled on a layer of pine wood placed on a piece of level and hard ground. The larger pieces form the base; the smaller ones are placed on top. The heap is covered with previously roasted fine stuff, which prevents a too rapid combustion.

The wood being ignited, the roasting process commences and is continued chiefly by the oxidation of the sulphur contained in the ore. Some of this may be recovered by making cup-like depressions in the covering near the top, in which a portion of the sublimed sulphur will collect.

After the oxidation or roasting has gone on for from two to four weeks, the pile is torn up and the well roasted ore separated from the imperfectly roasted layer, which is once more built up on a layer of wood, and

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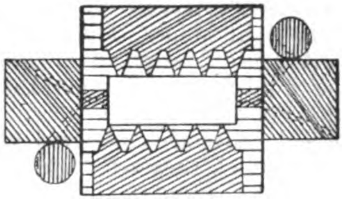

Fig 33

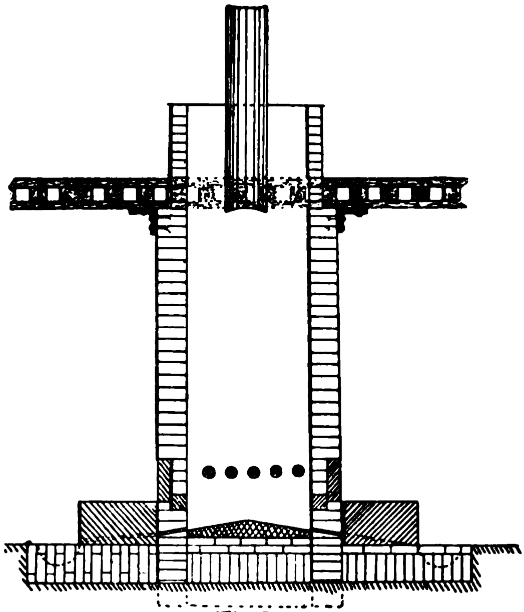

Fig. 34

rial directly exposed to the cold blast). These may vary in length from six to eighteen inches, and prevent the burning through of this portion of the walls and of the nozzles themselves, which they also protect against the corrosive action of sulphurous acid.

At the end of each tuyere is a glass-covered peep-hole, through which the condition of the interior may be watched in order to regulate the blast as required.

If the temperature becomes too high the noses melt away, and if too low they become unduly elongated.

Next, the regular smelting mixture is charged until the furnace is filled to the top. The slag flows off in a continual stream down a long gutter of brasque. During its descent it cools off, and is thrown aside with an iron fork.

From time to time the furnace is tapped on either end, the lead and matte flowing into shallow pots in the floor. The matte floats on the lead, and is removed by means of an eyebolt inserted before it solidifies. The tap-holes are placed in the fore hearths, and connect by means of a tube with the sump.

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which time it is frequently rabbled. Whenever needed, lime is thrown on the charge to prevent fusion.

The furnace is constructed of an exterior shell of rubble, and an internal lining of firebrick.

After roasting, the ore is transferred to the flowing furnace, which differs but slightly from the Flintshire furnace described above. The chief points of difference are, that it has but two doors at each end instead of three, as in the former. The charge is introduced through the two doors at the back, and spread over the bed, when the doors are closed and the heat is increased. About two tons are smelted in from two to three hours, when the reduced lead is tapped off.

The fused mixture is now dried by throwing lime on it, and once more spread over the bottom, adding from one to two hundredweight of scrap-iron. The doors are closed, and the charge is resmelted. On again tapping, the lead will flow into the pot, followed by matte and speise, and lastly by slag, which flows down a gutter into a pit.

The whole operation is usually completed in eight hours, with a consumption of from eight to nine hundredweight of coal per ton of ore.

The slag does not contain more than ½ to 1 per cent of lead and is usually thrown away, while the matte is roasted and resmelted.

LEAD IN THE UNITED STATES.

After having thus described the principal smelting processes employed in Europe, it remains to review the lead-smelting industry of the United States.

PRODUCTION OF LEAD.

According to the Report of the United States Geological Survey for the year 1888, the latest one issued, the lead production during that year amounted to one hundred and eighty thousand five hundred and fifty-five tons, of which twenty-eight thousand six hundred and thirty-six tons were produced from ores imported from Mexico, leaving a balance of about one hundred and fifty-two thousand tons as the quantity produced from American ores.

LEAD-PRODUCING REGIONS.

As large quantities of lead ores are interchanged between the different States and Territories, it is possible only to indicate the territorial production in a general way.

The figures given for 1888 are:

Colorado	73,000 tons, against 74,815 tons in 1887.
Utah	22,284 tons, against 22,838 tons in 1887.
Idaho	39,500 tons, against 20,000 tons in 1887.
Montana	13,125 tons, against 7,000 tons in 1887.
Nevada	2,400 tons, against 3,400 tons in 1887.

In the report for 1887 are, furthermore, given the following figures for Territories not mentioned in the report for 1888:

New Mexico and Arizona	8,000 tons.
The two Dakotas	1,000 tons.
Missouri and Kansas	25,687 tons.

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mixed and divided into three parts, one of which is assayed by the smelter, the other at the mine, while the third one is kept in reserve for reference in case of dispute.

For fluxing, dolomite, hematite, and old slag are used, and for fuel, charcoal, coke, or a mixture of both.

As the ore consists chiefly of carbonate of lead, no roasting is required, and what preliminary work there has to be done consists almost entirely in crushing.

The ore is mixed with the fluxing material in varying proportions, so as to produce the chemical combination desired. The mixture usually contains equal parts of iron, lead, and gangue.

The great advantage derived from preparing ore beds besides giving mixtures of known composition, is that of drying the ore, an operation which, if carried on in the furnace would absorb an enormous amount of heat.

Below will be found some typical charges of different smelting establishments in Leadville, as stated in the report of Mr. Anthony Guyard:

I.

Ore bed	100 pounds.	Dolomite	10 pounds.	Charcoal	15 pounds.
Unmixed ore	50 pounds.	Hematite	10 pounds.	Coke	20 pounds.
		Old slags	30 pounds.		
Ore	150 pounds.	Flux	50 pounds.	Fuel	35 pounds.

II.

Ore bed	200 pounds.	Dolomite	50 pounds.	Charcoal	80 pounds.
Low-grade ore	100 pounds.	Old slags	150 pounds.	Coke	60 pounds.
Various rich ores	200 pounds.				
Lead scraps	10 pounds.				
Ore	510 pounds.	Flux	200 pounds.	Fuel	140 pounds.

III.

Ores	310 pounds.	Dolomite	67 pounds.	Fuel	105 pounds.
		Hematite	17 pounds.		
		Old slags	60 pounds.		
Ore	310 pounds.	Flux	144 pounds.	Fuel	105 pounds.

IV.

Ore beds	500 pounds.	Dolomite	80 pounds.	Charcoal	95 pounds.
Various ores	200 pounds.	Hematite	170 pounds.	Coke	65 pounds.
		Old slags	80 pounds.		
Ore	700 pounds.	Flux	330 pounds.	Fuel	160 pounds.

V.

Ore bed	200 pounds.	Dolomite	15 pounds.	Charcoal	36.5 pounds.
Various ores	100 pounds.	Hematite	15 pounds.	Coke	36.5 pounds.
		Old slags	50 pounds.		
Ore	300 pounds.	Flux	80 pounds.	Fuel	73.0 pounds.

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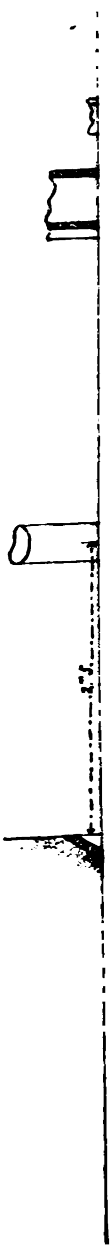

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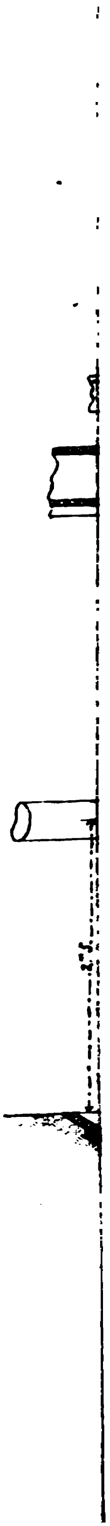

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bushels of charcoal. As soon as molten metal makes its appearance at the top of the siphon tap, a few pieces of live coal are placed on it to prevent its cooling.

The charging is begun by throwing old slags into the furnace as a test of the temperature. As soon as these have become quite liquid the regular charge is introduced, leaving, as usual, a depression in the center for the reception of the fuel.

After the furnace has begun to work it becomes necessary, from time to time, to remove any accretions adhering to the inside of the walls, which is done with bars and sledges, and during this operation the blast is, of course, turned off.

Flue and chamber dust is usually mixed with lime and spread in suitable quantities over the charge and smelted with it. This is a very good way to dispose of this troublesome substance.

The furnaces are worked with a dark top, which is also the case in Freiberg and the Harz. This means that no signs of incandescence appear at the mouth of the furnace, the only symptom of the smelting process going on below being the thick, black smoke ascending through the chimney.

After the furnace has commenced to work with regularity, it becomes necessary to draw off the molten slag periodically, usually every fifteen or twenty minutes. When this has to be done, a cast-iron slag pot is wheeled close to the fore hearth under the slag gutter. A tap-hole is made in the tympstone at the middle near its base, through which the slag flows out over the fore hearth down the gutter into the pot. As soon as this is filled, the hole is plugged up with clay and the pot wheeled away to the slag heap, where it is dumped.

From time to time lead is ladled out of the lead pot and poured into cast-iron molds.

When a furnace needs repairing the feeding is suspended, but the blast is kept on until the contents are entirely molten. The charge soon burns with a bright top and the furnace emits voluminous heavy, white fumes. When the charge has reached the level of the tuyeres, the furnace is emptied of its fluid contents, when the breast is removed and the bullion ladled out of the sump.

PRODUCTS OF SMELTING.

The quality of the bullion differs a good deal, according to the care with which the smelting is conducted. The following are two analyses made by Mr. Anthony Guyard, which will give a general idea of the composition of the bullion produced at Leadville:

Lead	99.0798240	98.492379
Silver	0.6112445	0.793417
Gold	0.0000888	0.000891
Copper	0.0479100	0.071450
Tin	Faint trace.	0.000897
Bismuth	Faint trace.	0.011791
Arsenic	0.0391365	0.219528
Antimony	0.2138940	0.347881
Iron	0.0063000	0.012600
Zinc	0.0016052	0.000232
Cadmium	Faint trace.	Faint trace.
Sulphur	None.	0.048934
	100.0000000	100.000000
Ounces of silver per ton	178.275	231.408
Ounces of gold per ton	0.026	0.260

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one, and was formerly used exclusively. It is based on the rapid oxidizability of lead when heated with free access of air and on the non-oxidizability of silver under the same circumstances. The apparatus used for this operation differs.

The German Cupelling Furnace

Has a solid refining bed and a movable cover, the English a movable bed and a solid cover. The former is the older one. A description and illustration of it is given by Agricola in his book on metallurgy, printed three hundred years ago. It is constructed of stone or brick and refractory material. The refining bed has an oval form, and is made of a course of firebricks set on edge, on which are spread several layers of marl. The cover is a shallow iron dome plastered on the interior side with fire clay. It may be removed by means of a crane and chains. The fireplace is lateral, and connects with the furnace proper by means of a wide opening, *B*. Lead is charged during the operation through the opening marked *D* in Fig. 37.

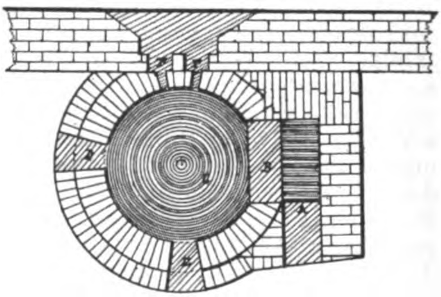

Fig 37.

F, *F* are apertures for the admission of two tuyeres. The blast which is directed on the surface of the lead bath assists in the oxidation and drives the scum and litharge towards the aperture *E*, through which it flows out on the floor. This opening is almost completely closed up with fire clay at the beginning of the operation, during the progress of which it is gradually cut down to suit the level of the litharge.

The refining bed of marl is concave, the center being about twelve inches deeper than the rim. After the bed has become thoroughly dried three fourths of the bullion to be treated, which is cast in small hemispheres, is piled on it, the convex surfaces downward so as not to injure the lining. An average charge weighs about one hundred hundredweight, so that seventy-five hundredweight are placed in the cupelling furnace at the beginning, and twenty-five hundredweight at a later period of the operation. Upon the bullion are placed wood shavings and brush wood, which are ignited together with the fuel in the fireplace *A*.

Next the cover is moved into place and luted all around the edge to the walls with fire clay; lastly, the blast is turned on and the bullion melted. After from three to five hours this is accomplished, the lead is perfectly liquid, and a pasty, imperfectly melted mass, termed "Abzug," covers the surface of the metal. This scum consists of a mixture of

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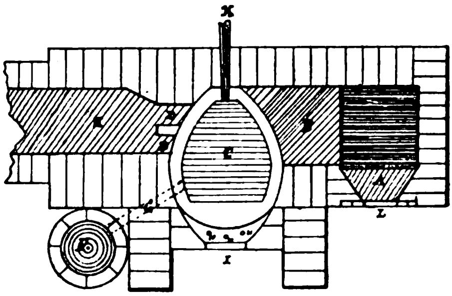

Fig. 38.

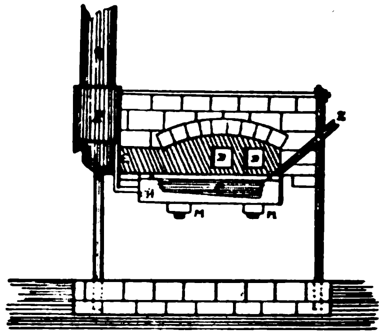

Fig. 39.

This frame is about five and one half to six inches deep, four feet wide in front, and three feet wide in the rear. The frame is filled with moistened bone ash which is firmly pressed into it, after which a cavity is scooped out, leaving a lining of two inches in thickness at the rim, increasing to three inches at the bottom. Into the front end, three holes, *H*, *H*, *H* (Figs. 38 and 39), are drilled to serve in succession as outlets for the litharge during the operation. After the first one of these has become too much corroded to be any longer serviceable, it is closed and one of the remaining two opened. A fire bridge *B*, fourteen to eighteen inches high, separates the test *C* from the fireplace *A*. The fumes and products of combustion escape through two openings *D*, *D*, into the main flue *E*. The frame is held in place by four wedges *M*, *M*, supported by bars which press it against an iron ring firmly built into the masonry.

To prevent the test from cracking, it is necessary to heat it gradually and cautiously to a bright red, when part of the charge, previously melted in the iron pot *F*, is introduced through the gutter *C*. At first the metal becomes covered with a gray dross, which melts when the temperature increases. Now the blast is turned on, which enters through the nozzle *K*, and forces the litharge towards the front, where it escapes through the hole *H*, and falls into a shallow cast-iron pot running on wheels. Fuel is added through the door marked *L* in Fig. 38, while the one marked *I* is used for watching the operation. *Q* is a flue which carries off the fumes collected by the hood *P*. In cases where the lead is introduced into the test without previous melting, openings are provided in the back wall near the tuyere through which the pigs may be charged. In proportion as the metal in the test diminishes, fresh lead is added.

When the charge has become sufficiently enriched to render its transfer to the refining furnace desirable, a hole is drilled into the bottom of the test and the alloy tapped into a pot placed on wheels, after which the hole is plugged up and a new charge introduced.

The final refining is conducted in a furnace of similar construction, in which the enriched alloy is placed and treated as above until the last traces of lead have become oxidized, and the brightening of the silver indicates the termination of the process, when the blast is turned off, the fire raked out, and the silver button allowed to set, after which the frame containing it is lowered into a small car and wheeled away to cool off.

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series may, in the same way from time to time, receive lead yielding the same amount of silver as the metal which they severally contain. During these operations a quantity of oxide is produced, and when the charge in each pot is melted down, it is always carefully skimmed before cooling. The amount of dross from working lead containing twenty ounces of silver per ton, may be estimated at 25 per cent of its weight.

The enrichment attains its limit when seven hundred ounces per ton are reached, as at that point the crystals and the liquid alloy have the same composition, and further concentration by these means becomes impossible. The lead in the market pot should not contain more than one half ounce of silver per ton.

Based upon the same principle, being in fact but a modification of the Pattinson process, is the

Laveissière Process,

The chief distinction of the two being, that in the latter the stirring is done by wheels driven by machinery instead of by hand, as in the former.

The apparatus consists of a melting pot and a crystallization pot, both of which are usually constructed of cast-iron and arranged in such a manner that the molten metal may be tapped from the melting pot into the crystallizing vessel. On a level below the latter are several receptacles for the enriched alloy, connected with the crystallization pot by several pipes.

The stirring apparatus consists of a shaft inclosed in a revolving cylinder, which are made to move in opposite directions. To the lower end of each are fitted blades, which almost touch the sides of the vessel, thereby preventing any incrustation of lead. It is necessary to provide this apparatus with a tightening pulley or some similar contrivance, in order to be able to regulate the power and adjust it to the increasing resistance caused by the progress of crystallization.

The operation is commenced by melting the bullion to be treated, after which it is run into the crystallization pot and the machinery is set in motion, when, by lowering the temperature, the formation of crystals is effected. As soon as the required quantity, usually two thirds, is obtained, the lateral valves are opened and the liquid alloy drawn off into the receptacles provided for it. Bullion of the same tenure as the crystals in the pot is added to them, when the operation is continued in the same way until alloy rich enough to make it suitable for cupellation is obtained on the one hand and market lead on the other.

The cakes of lead formed in the molds for the reception of the enriched alloy are hoisted by means of cranes and brought back to the level of the melting pot to be retreated.

A third system, based upon the same principle, is termed the

Marseilles Process.

Recourse is had in this process to the action of steam, in place of the iron rod in the Pattinson and the stirrers in the Laveissière method, which causes an agitation of the liquid metal, resembling ebullition, and has the desired effect. The apparatus required consists of vessels for melting the bullion, a pot for crystallization, a boiler, and a crane. The

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melting pots, of which there are usually two, have a capacity aggregating nine or ten tons. They are placed on a higher level than the crystallizing pot, which is larger, being capable of containing from fifteen to sixteen tons.

On a level with the rim of the lower kettle is a platform, which facilitates skimming and also permits a close observation of the process.

The crystallizing pot is cast with three openings in the bottom, two of which serve for tapping and are closed when not used. The third one serves for the admission of steam, being provided with a valve for the purpose of preventing lead from entering and solidifying in the tube.

The fused metal is run into this pot and the steam turned on until the normal pressure of forty-five pounds is reached and a full charge of lead has been admitted.

To cause an equal distribution of the steam, a circular disk is placed horizontally over the inlet steam pipe.

The vessel is covered by sheet-iron plates, moving in frames of angle-iron, surmounted by a chimney connecting with condensing chambers.

These plates are raised from time to time and metallic particles adhering to the sides removed with iron chisels.

When a sufficient quantity of lead has crystallized (usually two thirds), the enriched liquid portion is tapped off into molds placed on the floor. Over the outlet pipes are placed iron strainers which prevent the escape of any crystals. The castings or pigs obtained in a series of operations, are hoisted by means of a crane and ranged around the furnace, according to their percentage of silver, until a sufficient quantity of a certain tenure has accumulated for a new series of operations.

After the enriched alloy has been tapped off, a new charge of the original bullion is tapped at a high temperature onto the crystals and the operation repeated.

When it is desired to remove the crystals, either because they are sufficiently impoverished or for any other reason, they are melted and tapped off.

DESILVERIZATION BY ZINC.

This process is founded on the fact that when lead and zinc are melted together and the mixture is allowed to cool slowly, the zinc solidifies first and forms a layer, or crust, which can easily be removed, and that this crust contains nearly all the silver originally contained in the lead.

The process, originally introduced by Parkes, is carried on in the following way: The lead is melted in a large iron pot and heated sufficiently to fuse a piece of zinc placed on its surface as a test of the temperature. The zinc is added in three successive portions: first, two thirds of the quantity required; later one quarter, and lastly the remaining one twelfth. After the first portion has been added the two metals are intimately mixed by stirring with a perforated ladle for about half an hour, during which operation the temperature is kept up to the melting point. At the expiration of this period the fire is dampened and the pot allowed to cool. As soon as the zinc crust has sufficiently solidified it is removed, and particles adhering to the sides of the pot carefully detached and the surface skimmed off until the lead begins to crystallize. It is now again heated to the melting point of zinc, the second portion of that metal is added, and the stirring and

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skimming conducted as before. Finally, the third addition of zinc is made, and the operation once more repeated. The proportion of zinc added is regulated in accordance with the amount of silver contained in the lead. Trials made at Clausthal have proved the following proportions of zinc to be necessary for the complete desilverization of the various qualities of lead:

Lead containing 9 ounces of silver per ton, requires $1\frac{1}{4}$ per cent of zinc.
Lead containing 18 ounces of silver per ton, requires $1\frac{1}{3}$ per cent of zinc.
Lead containing 36 ounces of silver per ton, requires $1\frac{1}{2}$ per cent of zinc.
Lead containing 54 ounces of silver per ton, requires $1\frac{2}{3}$ per cent of zinc.
Lead containing 108 ounces of silver per ton, requires 2 per cent of zinc.
Lead containing 144 ounces of silver per ton, requires 2 per cent of zinc.

The zinc crust carries along with it, besides the silver, a considerable percentage of lead. This is recovered by liquation in two iron pots, one of which is placed higher than the other and is connected with it by a pipe cast onto its bottom.

The zinc skimmings are strongly heated in the upper pot and the eliquated lead flows into the lower one through the pipe mentioned, while the argentiferous zinc residue remains behind. The lead carries with it part of the silver and zinc, which, after cooling, is skimmed off. The eliquated and purified lead is added to the original metal before the last addition of zinc.

Flach's modification of this process is conducted in three cast-iron pots, set in brickwork at a convenient height above the floor, and heated by separate fireplaces. Two of these pots hold about six tons each, while the third one has a capacity of twenty tons.

The desilverizing process is conducted in the larger pot, and the argentiferous zinc crust is removed to one of the smaller ones by means of perforated ladles.

When one of these pots has become filled, it is subjected to liquation, and the other one serves as a receptacle for the skimmings. The eliquated lead is added to the metal in the desilverizing pot at the same period as in the former case. The argentiferous alloy is in both cases smelted in a blast furnace to separate the last particles of lead, which is finally cupelled.

The lead remaining in the larger vessel is ladled into the pan of an improving furnace and kept at a red heat for about twelve hours, during which it is frequently skimmed; at the expiration of this period it is cast in molds, and is salable as market lead.

Another method of dezincification of lead was introduced by Cordurié: The lead is brought to a red heat and superheated steam is forced through it, when the oxygen contained in the latter causes the zinc to oxidize, while the lead is but slightly affected. The zinc oxide rises to the surface and is skimmed off.

The zinciferous silver alloy may be treated in the same way, when the zinc will oxidize and separate from the argentiferous lead alloy. The latter is finally cupelled to obtain pure silver and litharge.

Still another way to separate zinc from lead is the following: The alloy is kept at a moderate temperature under a cover of chloride of lead for about twenty-four hours and continually stirred, when the metallic zinc is converted into chloride of zinc and the chloride of lead into metallic lead.

A process having the same object in view has been invented by Ber-

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grath Schnabel, of Clausthal, Harz, which consists in the digestion of the argentiferous zinc and lead oxides with a hot solution of carbonate of ammonia under pressure in gas-tight vessels.

This treatment has the following results: The zinc oxide dissolves and is converted into carbonate of zinc, and a silver-lead alloy is obtained in a suitable state for refining.

The ammoniacal solution is distilled to recover ammonia, and the basic zinc carbonate is converted by calcination into the oxide, which is used as paint.

Messrs. Balbach and Faber du Faur have introduced a dezincification process, conducted in a retort furnace, represented in cross-section in Fig. 41.

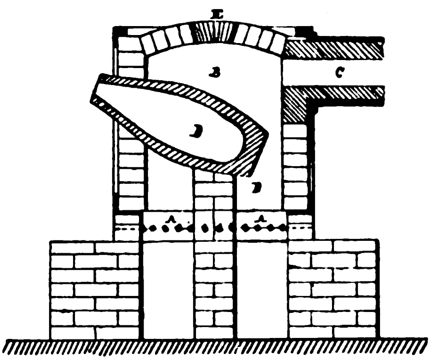

Fig. 41

A. Grate. *B*. Fireplace. *C*. Flue. *D*. Retort. *E*. Feed-hole for fuel.

This may be heated by coke or charcoal. If gas or coal oil is to be used, the construction has to be changed somewhat.

The retort is heated until red hot, when the charge is introduced. This consists of a mixture of finely broken zinc crust and charcoal smalls, and varies according to the size of the furnace from two hundred and fifty to four hundred pounds of zinc crust, and three to five pounds of charcoal.

The charge being introduced, a condenser is placed over the mouth of the retort, and the temperature is at once raised to white heat. Should it be neglected to maintain this high temperature uniformly, a crust of chilled alloy will form on the metal, under which zinc fumes accumulate, which cause an explosion, if the temperature is once more raised.

The metallic zinc collects in the condenser, from whence it is from time to time removed, remelted, and cast into thin plates, to be used again in desilverizing.

In this way, from 60 to 80 per cent of the zinc is recovered—40 to 50 per cent in the metallic state, and 20 to 30 per cent as oxide. The latter collects around the mouth of the condenser, where it is scraped off, packed into suitable vessels, and taken to zinc works for reduction.

The argentiferous lead remaining in the retort is tapped off, cast into thin plates, and cupelled in an English refining furnace. The entire operation requires from eight to ten hours, according to the percentage of zinc in the alloy.

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MINING OF GOLD ORES IN CALIFORNIA.

By JOHN HAYS HAMMOND, E.M.

GEOLOGICAL.

It is a theory universally maintained by all students of cosmogony that the earth was at one time a molten oblate spheroid. This spheroid has been cooling off through an incalculable length of time, and to this secular refrigeration of the globe is to be ascribed the most potent geological phenomena of its history. At first, the exterior or crust of the earth cooled faster than the interior, losing its heat both by conduction and by radiation into the cool enveloping atmosphere. Later in this period of refrigeration, the interior of the globe cooled the more rapidly, as the exterior crust had by this time acquired a temperature approximating the temperature of the atmosphere. This cooling was accompanied by contraction.

The slowly cooling exterior adjusted itself to the more rapidly cooling and shrinking interior or nucleus, in consequence of which the crust eventually had to yield somewhere.

This yielding took place along lines of least cohesion. Thus, by a gradual subsidence of the crust, geosynclinals or trough-like depressions of the earth were formed; as a result of this subsidence a mighty horizontal pressure was exerted, which caused the upswelling of the crust of the earth, and the formation of geanticlinals or mountain chains.

In the Paleozoic era, the earth now occupied by the Sierra Nevada Mountains was a marginal sea bottom, receiving sediments washed into it from the continental masses at that time lying to the east.

The duration of this period of sedimentation was very great, as evidenced by the immense depth of the sediments deposited, which reached many thousands of feet.

During this period there was slow subsidence of the marginal sea bottom. At the end of the Jurassic period this line of deep sediment, in conformity with the law of secular refrigeration referred to, yielded to the lateral pressure caused by the sinking of this region and the great uplift which gave rise to the Sierra Nevada Mountains. By the elevation of the Sierra Nevada Mountains the coast line was transferred farther west. The marginal sea bottom of the Cretaceous period derived its sediments from the newly made Sierra Nevadas. At the end of the Cretaceous period, by the same phenomena that gave rise to the Sierra Nevadas, the Coast Range was formed. By metamorphisim the upraised plastic sediment was converted into rocks of lithological character, varying with the character of the sediment itself, and with the degree of metamorphism to which it was subjected. The phenomena of lithification is specially well exemplified in this State by all stages of the metamorphisim of strata, from the imperfectly indurated schists to the most highly crystalline rocks.

The metamorphic origin of many granites is exemplified by the insen-

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longitudinally and in depth. Many of the so called granitic rocks are, strictly speaking, syenites and diorites.

MINERALOGICAL CHARACTER OF THE AURIFEROUS ORES.

Mineralogically the ores consist generally of a quartz gangue, carrying free gold and iron pyrites. With the iron pyrites are sometimes associated arsenical and copper pyrites, and more frequently galena and zinc-blende. In some of the gold ores are found auriferous tellurides, and also, occasionally, some other of the rarer minerals. These latter constituents are usually of little economic importance, and their presence may practically be disregarded. Quartz is the characteristic matrix of the veins, though other matrices occur. Sometimes the wall rock fills the vein, and constitutes the gangue of the ore. Calcspar often accompanies the quartz veinstone, though it very rarely forms exclusively the matrix of the auriferous ore.

The value of gold ores worked in California generally varies from $3 50 to $8 a ton in the low-grade ores, up to $15 to $30 a ton in the high-grade ores. I should place $10 to $12 a ton as a rough estimate of the average grade of ore at present treated. The percentage of sulphurets (iron pyrites principally) will vary from 1 to 5 per cent of the ore milled. Two per cent would represent about the average pyritous contents of the ores. The percentage of sulphurets contained in the ore and the value of the concentrated sulphurets are but rarely of so little economic importance as to be ignored in the milling of the gold ores. The great majority of gold mills have their plants adapted to the saving of the sulphurets; the value of which, while usually subordinate to that of the free gold present in the ore, nevertheless is a significant factor in the output of the mill. I should estimate the average value of the sulphurets saved in the State at from $80 to $90 per ton of concentrates. In the low-grade ores the gold occurs disseminated throughout the ore in particles rarely visible to the naked eye. In ores of high grade it often occurs massive and sometimes in lamellæ along the planes of division in the quartz ("ribbon rock"). The gold often assumes the form of wire (filiform), and is also occasionally arborescent.

Ores showing considerable free gold ("specimen ore") are often sold to jewelers, who pay from $20 to $27 per ounce of gold contained in the quartz.

The pyrites is generally massive in character, though sometimes it occurs crystallized. Crystallized iron pyrites rarely carry much gold. The sulphurets contained in the country rock inclosing the vein are likewise of but little value.

"FAVORABLE QUARTZ,"

"Good looking rock," "hungry looking rock," etc., are among the many familiar mining expressions to denote the appearance of ore. While the character of ore ("rock") that would be "good looking" and valuable ore in one mine might be of no value in another mine, it is nevertheless true that in any particular mine such terms are indicative of a real difference in the quality of the ore.

It is difficult to clearly define the above descriptive terms, but there is undoubtedly more than a fancied recognizable difference between

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beyond such points. Ramifications and bifurcations are very common in veins. These features may indicate a dying out of a vein, or merely, which is often the case, the splitting up of the vein for a short distance and the subsequent reunion of the branches. "Horses" are often formed by the splitting of a vein, so as to include a block of barren ground between the branches. "Horses" in veins are likewise due to the fact that before the fissure was mineralized a block of ground fell into the fissure from one of its walls, the solution subsequently depositing mineral on either side of this "horse."

FAULTS.

The veins of California show, but in few instances, the results of any faulting or displacement. It is true that slight movements did take place in some of the veins subsequent to their formation, but only to the extent, usually, of crushing and crumpling the vein-filling. In the few mines where faulting has occurred the displacement was not great.

CROPPINGS.

Generally the quartz veins, because of their superior resistant power to disintegration, as compared with the inclosing country rock, outcrop more or less conspicuously. In Mariposa County the quartz stands in the Mother Lode fully eighty feet above the inclosing slates. This is a remarkable illustration of prominent croppings. Its width at the top of the croppings is about eight feet, while it is about twenty feet at the base of the croppings. On the other hand, some of our best veins have but very inconspicuous lines of croppings. In some places, indeed, owing to its relatively soft, decomposable character, the apex of the vein does not reach the surface, but is covered over by several feet of alluvium.

There are likewise, though of rare occurrence, what are known as "blind" veins, which do not crop out anywhere, and are discovered usually by accident in the course of underground explorations for other veins. Some of these veins have developed into valuable mines.

Where croppings consist of quartz of a "ribboned" character, and where it is considerably mineralized, it is more susceptible of rapid disintegration than croppings that consist of unmineralized and massive quartz. In the former case the oxidation of the pyritous contents (sulphurets) of the quartz (gangue) by the action of atmospheric agencies, and the subsequent removal by water of the soluble salts thus formed, leaves an ocherous deposit along the line formerly occupied by the quartz croppings. This character of vein cropping is known as "gossan" by English miners, and by the respective terms "Eiserner hut" and the "Chapeau de Fer" of Germany and France. The depth of this "gossan," or iron hat, often extends from one to thirty feet below the surface, and because of its being easily mined and readily worked by the most primitive process for extracting the gold, which is readily saved by reason of its being in the "free" state, and the material being already much disintegrated by natural agencies, before referred to, was eagerly sought for by the early vein miners.

SYSTEM OF VEINS.

In the same mining district, or, indeed, even within the limits of the same claim, there may be several distinct veins. Usually there is more or

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degrees from the horizontal. In but few places does it exceed 30 degrees inclination. Most of the veins of the State exceed 45 degrees dip. The same vein may vary greatly in its angle of dip, without any appreciable change in the value of the ore, though in some mines such changes are significant in that regard. An opinion quite prevalent among our miners is to the effect that the contour of the hill determines the course of the veins. The converse is more likely to be true in most instances, as the contours of the hills were entirely different from those of to-day at the time the veins were formed, so the present contours could not have influenced the course of the veins. The present topographical features differ greatly from those that existed at the time of the formation of the veins. The contours of the present hills are of recent origin, and consequently could not have determined the course of the veins.

PAY SHOOTS.

While the vein throughout the entire extent of the claim may be more or less mineralized, the pay ore will be almost always found limited to certain zones called "pay shoots."

Usually, the term pay shoot is a relative one, depending at times not only upon the presence of ore in the vein, but also upon the economic conditions of mining and milling at the mine in question.

The improvement of the facilities of mining and milling at the property, in some instances, would very materially increase the area of the pay ore, *i. e.*, extend the length of the pay shoots. The relative delimitation of the "pay shoot" is especially apparent where the value of the ore does not decrease greatly after the limits of the pay shoot are reached. Usually, however, there is a marked difference in the value between the ore of the pay shoot and the vein material beyond these limits. In some mines the fissure outside the shoots is filled with material different in character from that constituting the gangue or vein-filling of the pay shoots.

In the pay shoots quartz is the predominant vein material, while outside the shoots material derived from the country rock may fill the fissures.

Sometimes an intrusive dike of greenstone (diorite or diabase) or other eruptive rock occupies the fissure in the spaces outside of the pay shoots.

Quartz carrying but a trace of gold, or carrying gold in a quantity too small to pay likewise, often constitutes the fissure-filling outside of the pay shoots.

The limits of the pay shoots may be also due to the pinching out of the vein, in which case the fissure continues as a mere seam. Or it may be owing to the decrease of the vein in size, or to an increase of the rock in hardness, in consequence of which the cost of mining is so much increased as to render the further extraction of the ore unprofitable.

On the same vein, within one claim, there may be several pay ore shoots separated by intervals of barren ground. Sometimes two or more of these shoots unite, forming one continuous shoot. On the other hand, a large shoot may be split up into two or more smaller shoots, with barren ground between them. In pay shoots, of course, much non-paying ore is exploited. Many tons are extracted within the limits of the pay shoot that do not pay for the cost of mining, but which must be,

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SAMPLING OF VEINS.

The most important factor in the determination of the value of a mining property is the adoption of a correct system of sampling the vein. In view of its importance we shall briefly outline the best system of sampling.

We shall assume that the vein has an average width of about four feet, varying say from one to six feet. Commencing at the bottom level we take from the face of one of the drifts across the entire width of vein sample No. 1. To obtain this sample we break down from fifteen to thirty pounds of vein matter, allowing the broken rock to fall upon a piece of rough canvas stretched upon the floor of the drift. In selecting this sample we aim to break down, as nearly as possible, rock to represent the average character of the material at this point. Waste as well as clean quartz occurring in the vein must be included in the sample. The fifteen to thirty pounds of rock thus broken down are spalled upon the canvas and quartered so as to obtain a sample of from four to six pounds. This sample is sacked and marked "Sample No. 1," and sealed. The locality from which the sample is selected, the width of the vein at that point, etc., are noted in a book kept for that purpose.

In a similar manner sample No. 2 is taken, extending from point at which sample No. 1 was taken, across the vein towards the shaft, a distance of about ten to fifteen feet. About the same quantity of material is broken down and the sample selected in the same manner as sample No. 1. This sample is likewise sacked, marked, and sealed.

Where there is a pinch in the vein, or where the vein is filled with waste, or where the rock is obviously of a grade too low to be profitably worked, it is not necessary to take a sample, but a note is made in the book describing the condition of ground at the point where no sample was taken.

In this way samples are taken from all parts of the mine, the winzes, upraises, backs of the stopes, drifts, shafts, etc., where there are exposures of ore.

These samples are all kept separate, and their values separately determined, as per method elsewhere suggested in this article. The values of the samples thus obtained are indicated on a diagram of the mine. The extent and method of occurrence of the pay shoot is thus graphically illustrated, and it can be readily seen whether or not the pay shoot increases in length with increase of depth; likewise the continuous or the spotted condition of the pay ore becomes apparent.

The determination of the cost of mining and milling having been made from an investigation of the conditions of the mine examined, the delimitation or definition of the pay ore shoot, and the extent of pay ore ground in the mine, can be readily ascertained.

In many wide veins the pay ore does not extend across the entire width of the vein, but is confined to a streak near the foot or hanging wall of the fissure. Sometimes, but more rarely, this streak occurs near the middle of the fissure. The width of this pay streak is sometimes great enough to be stoped profitably, whereas the stoping of the entire width of the vein would not pay.

In sampling such veins, where the fissure is not homogeneous in the value of its vein-filling, the sample should not be taken across its entire

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quicksilver, which bring in contact with the gold by rubbing it throughout the pulp. Collect the small amalgam and boil it slowly in nitric acid in a test tube until the quicksilver disappears.

The application of heat (of an alcohol lamp) hastens the process by dissolving the quicksilver. Pour out carefully the acid and wash out with water all traces of acid left in the test tube, then pour the gold carefully into an annealing cup, and heat over the alcohol lamp until the gold is thoroughly dry, when weigh it. This gives the amount of free gold per pound of ore, from which the free gold per ton may be readily calculated.

An approximation as to the fineness of the gold can be made by the eye sufficiently accurate for these tests.

Instead of "cutting" the amalgam by the use of nitric acid the quicksilver may be volatilized by the blowpipe. The tailings from this sample should be saved and the sulphurets collected by washing off the sands. The sulphurets are to be then weighed; from this weight the percentage contained in the ore is ascertained, and the assay made to determine their value per ton.

A few small vials with carefully weighed amounts of gold will be found useful for comparison with the pannings made upon the field. Such measures materially improve the guesswork otherwise practiced.

PROSPECTING.

The presence of rich placers does not necessarily indicate the proximity of paying veins. The gold of the placers has been derived, it is true, in most instances from the croppings of veins in the vicinity; but while the placers may be rich the gold they contain may represent the disintegration of a very large amount of gold-paying quartz, and the subsequent concentration of the gold under exceptionally favorable conditions in the placers.

Often, likewise, much importance is attached to the discovery of rich float rock and undue assumptions of rich veins inferentially made.

DEVELOPMENT OF PROSPECTS.

After the location of a vein is made (and its value determined by the system before explained) the prospector should exercise proper discrimination as to the character and the site of the exploratory work he purposes doing, to ascertain the value and permanency of the ore discovered.

When feasible, the exploratory work in the first instance should be confined as nearly as possible to such portions of the claim as give the best surface showing. The Mexican system of prospecting consists in following as closely as possible the discovered ore body. When the ore body gets barren and appears to give out, should they decide to continue prospecting work further, the Mexicans confine their explorations, for the most part, to the proximity of the ore bodies of already established value. This is a commendable feature in their system of mining, as it increases the probability of finding other ore bodies, should such exist, and curtails much unnecessary dead work incident to the system of explorations usually conducted in our country. Of course, where the surface indications or the developments in adjoining mines render probable or likely the existence of other ore shoots, prospecting must be

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The character of the ground will determine the most economical method of its exploration; but these explorations should be so planned as to cover the most ground with the least amount of exploratory work, and the work should be so laid out as to avoid the duplication of results. This seems axiomatic, but frequently, to illustrate, long drifts are run in ground, the character of which had already been so satisfactorily established by other work as to be susceptible of reliable determination by sinking a winze from an upper level to prove the absence of ore bodies. Therefore, in ground in which the chances of discovering valuable ore bodies are very slight, is this tendency to run drifts too frequently to be avoided. Thousands of dollars have been expended without regard to the observance of some such scheme as suggested, and there are few mines where much money has not been thrown away by fruitless exploration of this character. In other words, the sinking of a winze a short distance, or the raising of an upraise for a short distance, will oftentimes conclusively establish the absence of pay ore bodies within the region to be explored, without the necessity of running frequent drifts through this barren stretch of country.

Of course, no arbitrary system can be laid down as to the best system of prospecting, owing to the great differences that prevail in the occurrence of the ore bodies in the various mines; but there should be a *system* and there should be less of the indiscriminate and indeterminate exploratory work so common in this State. Where the vein is flat and small, and subject to many pinches and changes of strike and dip, it sometimes becomes necessary, in case the vein is lost, to defer the extension of the drifts until the stopes have advanced far enough to indicate the direction in which the extension of the vein may be looked for.

DIAMOND DRILLS.

Within comparatively short time great improvements have been made in diamond drilling machinery as applied to exploratory work in mining. In the Eastern States considerable success has attended the introduction of these drills, especially in the operation of iron and coal mines. In mines of these classes diamond drills are eminently well adapted to the purposes of explorations, because of the peculiar character of the deposits in question. Diamond drills have also been employed with success in many of our western mining districts, but as yet to a limited extent in the gold mines of California.

As compared with the already recognized value of the diamond drill as an adjunct to the mining plants in coal, iron, copper, lead, and silver mining operations, their use will be but exceptional in gold mining. Nevertheless, there are many classes of our gold deposits where diamond drills can be very advantageously employed for prospecting purposes. Where the veins are narrow and the pay shoot undergoes apparent pinching, or exhibits frequent changes of dip, strike, etc., or where the character of the gangue or vein-filling of the pay shoot is of no clearly marked difference (save in respect of gold tenure) from that of the barren portion of the ledge, their use will not, as a rule, be advantageous.

On the other hand, where the pay ore bodies are wide and the pay shoot long, and there exists a conspicuous difference between the pay ore bodies and the barren ledge (as to the character of the vein-filling, etc.), drills may be, in such instances, of utility.

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is started from a raise which was previously made to the level above to obtain a current of air.

In this system, the deads or waste is piled back as the stopes progress. When the ore has been extracted, the block of lode is thus replaced by a block of waste occupying entirely or in part the same space. Mills or chutes are carried up as stoping progresses. These mills or chutes carry the ore to the level below, where it is drawn into the cars. Sometimes these chutes are lined on the sides and bottom with lumber; sometimes only on the bottom with lumber, while the sides are lined with small poles or with rocks piled up.

In quartz veins having a steep pitch these chutes must be well cribbed. These chutes are from twenty-five to fifty feet apart.

From twelve to fifteen feet is about the extreme distance to which a man can shovel the material broken in the vein, consequently in order to avoid the more expensive method of using wheelbarrows, the chutes must come within the above limits. Where the vein is wide (forty feet or more for instance) the chutes are carried near the middle of the stopes. In veins of greater width than forty to fifty feet, there is usually one chute near the hanging and another near the foot wall of the stopes.

Where the material to be shoveled is very heavy, as in lead mines, the chutes are kept very close. An angle of 45 degrees is necessary to have the ore carried down the chutes by gravitation. Where the chutes are flatter, owing to the flat character of the vein, more or less shoveling is necessary. In some flat veins this is an item of considerable expense. Where the chutes are flat a chain fastened at the upper end may be used to start the ore. On the other hand, where the vein is very steep, "set-offs" are required to prevent undue wear and tear of the chute in case the levels are very far apart.

Under-hand Stoping.—Under-hand stoping consists in beginning the removal of the blocks of ground at one of its upper corners. In this method the waste is piled on stages or stulls, one of which is generally required for every stope. The workings resemble steps of stairs seen from above, and the stulls on which the waste is stored look like a staircase seen from below, the arrangement being just the reverse in appearance of over-hand stoping.

Over-hand stoping, as before said, is started from a raise, while under-hand stoping is started from a winze. From the raise or winze, as the case may be, the stopes extend in both directions, forming two wings, which resemble an inverted fan in the case of over-hand and a fan in ordinary position in case of under-hand stoping.

In under-hand stoping more timber is used than in over-hand stoping. In over-hand stoping one line of stulls is necessary just above the roof of the level, whereas, as before said, each stope, which represents a height of six to eight feet in under-hand stoping, requires a line of stulls. The expense of timber for under-hand stoping increases greatly with the width of the vein and with the lack of solidity of the walls. Consequently, this method is of economical application only in narrow veins, say, as a rule, two to four feet wide, though for short depths where the walls and vein are solid, greater widths may be worked.

On the contrary, over-hand stoping may be worked sometimes thirty feet or more in width, depending upon the character of the ground. Also, over-hand stoping possesses facilities for breaking down the stuff, for stowing away the waste, and conveying the air to the levels. It is

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The boilers most extensively used belong to the class of simple horizontal tubular boilers. They are made either singly or in pairs. The horizontal non-condensing engines with tubular boilers, such as are in general use here, have a duty of from seven and one half to nine horsepower per cord of dry yellow pine.

The drums or reels are made for either round or flat cables or rope. Where the shaft is inclined, and the hoisting is done by cars, round rope is used. In vertical shafts, where cages are used, flat rope is preferred. The drums should be of large diameter, to reduce the bending strain to which the rope is subjected. Ropes are of iron or steel. Where lightness and strength are especially necessary, as in the case of deep hoisting, steel is preferred. The ropes should be thoroughly tarred at least once every two or three weeks.

Ropes used in inclined shafts are subjected to more friction, and consequently last a shorter time than ropes used in vertical shafts.

Ropes at the Empire and North Star Mines, hoisting eighty to one hundred tons per day, last about one year. After a use of six months, however, this rope is moved to the side of the shaft which is not used for the purpose of lowering the men.

The flat rope at the Idaho Mine is three and one half inches wide and three eighths of an inch thick. It is steel, and lasts three years. This rope is tarred once in three weeks. The cost of this cable is $420, or 10 cents per pound. The length of this cable is one thousand one hundred feet.

The cable used at the North Star is flexible steel wire seven eighths of an inch in diameter. The cost of this cable per two thousand five hundred feet is $377.

In hoisting through vertical shafts, the gallows frame upon which the sheaves are supported should be fifty feet or more in height. The additional height reduces the liability of over-winding. There are several automatic devices connected with the hoisting hooks, from which the cable is suspended, for preventing over-winding.

In vertical shafts cages are used. These cages run upon guide timbers. The cages are provided with safety catches, which operate when the tension of the rope is suddenly released, and hold the cage fast in the guides. The safeties should be frequently tested.

Double-deck cages are preferable when hoisting from great depths, as their use increases the capacity of the shaft.

When the shaft is steep but not vertical, cages may be used, nevertheless, by having an adjustable platform, which insures a constantly horizontal position of the platform. Cages of this design are useful where there is a departure from verticality at any point of the shaft.

Self-dumping skeets are often used in vertical shafts instead of cages. They are useful for moderate depths, and especially for sinking, as they can raise rock and water at the same time. When the skeet reaches the surface, wheels arranged on either side are forced to pass between inclined guides, as a consequence of which the skeet is tipped sufficient to dump its contents.

In incline shafts self-dumping skips are run upon tracks. Where the incline is flat cars are generally used. There is an economy in having large cars of about one and one fourth tons capacity; as large, in fact, as are easily handled. Connected with and actuated by the reel or drum upon which the rope is wound, is one of various mechanical contrivances

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pany's reservoir, a distance of two miles, to the mine. The pipe is iron, twenty-two inches in diameter; three hundred inches of water are required for pumping, hoisting, air compressors, fans, etc. The pressure at the mine is five hundred and twenty feet; thirteen Pelton wheels are used.

The Empire has a pipe-line one thousand three hundred feet long, diameter twenty-two inches; water delivered at mine under pressure of four hundred and twenty feet. All the machinery is operated by this power, two hundred and fifty inches being used, inclusive of water for forty-stamp mill.

ELECTRICITY.

Electricity as a motive power does not indicate any inherent primal energy, but simply refers to the use of electricity as an agent of the transmission of power. Its application in this direction is so advantageous that undoubtedly electricity, as the agency of the transmission of power, will eventually almost entirely supersede the hydraulic, pneumatic, steam, and rope systems of transmission now in use. Besides the superior advantages it has in transmitting power, electricity is unequaled in the facilities it possesses in the subdivision and distribution of power.

Excessive loss in the development and transmission of electrical energy, and the reconversion of its energy into power, is rapidly being reduced by important mechanical methods in its use. It is probably only a question of a short time when this objectionable feature will be so far removed as to render electrical transmission of power almost universal. The loss of power militates against the economical use of electricity in many localities. There are, however, some places where the cost of the initial power, generated by the dynano, is so insignificant that loss of even a large percentage of this power in its transmission and reconversion is not a serious objection.

By the use of copper reels of large diameter, the loss of power is correspondingly reduced. This, of course, entails a correspondingly great increase in the cost of the electric installation. It must be observed in this connection that there is little, if any, depreciation in the value of the copper circuit; the copper is always salable, with little probability of much loss, as compared with the original cost in transmission.

As yet the introduction of electrical plants for mining purposes has not made much headway in California. Electricity, however, for the purposes of illumination is quite extensively used in this State. Where the cost of power to operate the dynamos is not expensive, electric illumination is to be recommended, both on account of the better light obtained and because this system of illumination reduces the liability of fire arising from accident common to other systems of lighting.

One of the leading electric motor companies states in its catalogue the following data as to the loss of power in the use of electricity:

1. The loss from steam and water power by conversion into current	10.0 per cent.
2. The loss by transmission by wire for one mile—10 per cent of 90	9.0 per cent.
3. The loss by reconversion by motor—10 per cent of 81	8.1 per cent.
Total loss	27.1 per cent.
This they place as the maximum loss, and guarantee an efficiency of	*72.9 per cent.
	100.0 per cent.

* No waterwheel known to the writer can realize the above efficiency.

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MINE DRAINAGE.

In many of the mining districts of California the topographical features admit of the drainage of the mines by deep tunnels. On the other hand, in some of the central mining districts, in Nevada and Amador Counties especially (which counties are the most important mining districts in the State), the absence of natural facilities require the more expensive system of draining the mine through shafts. The mines of Amador County are, comparatively speaking, not very wet mines. But few of the most extensively worked veins have to raise more than two miner's inches of water per twenty-four hours. One of the wettest mines along the Mother Lode in Amador County is the Wildman. This mine has a depth of about six hundred and twenty feet. It pumps from seventy-five to one hundred thousand gallons every twenty-four hours. The vein is but four feet wide.

The Plymouth Mine, which has a vein from thirty to fifty feet in width, upon which developments have been made to a vertical depth of over one thousand six hundred feet, and upon which extensive stoping and drifting has been done, yields only about eighteen thousand gallons per twenty-four hours. No pump is required at the Plymouth, the water being raised by buckets.

The South Spring Hill raises ten thousand gallons in twenty-four hours, a very small quantity for a mine developed to the depth of eight hundred feet.

The Zeile, with a depth of eight hundred and eighty-five feet, yields from fifteen thousand to fifty thousand gallons in twenty-four hours. The vein of the Zeile Mine is thirty feet wide, and the developments are extensive.

The principal mines of Nevada County, those in the Grass Valley and Nevada City Districts, are generally more wet than the mines of Amador County. Among the wettest mines of that section, and, indeed, of the entire State, are the North Star and Empire. The Idaho Mine is likewise, comparatively speaking, a wet mine, the water raised being over three hundred thousand gallons a day in summer, and double that amount in winter. Much of this water comes from the old workings of the Eureka vein, of which the Idaho vein is an extension.

The North Star raises about three hundred and sixty thousand gallons of water per day (about twenty-one miner's inches) in summer, and about double this amount in winter. During the winter of 1889–90, an unprecedentedly wet season, in addition to the ordinary plant three steam pumps were run. The aggregate capacity of the steam pumps was six hundred gallons per minute. Eight cords of wood per day were used for the steam pumps. The aggregate amount of water raised from the mine during this period was one and one half million gallons per twenty-four hours. The Cornish plunger was operated by water power, using one hundred and twenty-five miner's inches under a pressure of two hundred and thirty-two feet, equivalent to about sixty-seven horsepower. In summer the pump requires about seventy miner's inches of water.

The bulk of the water in all these mines comes from surface sipage. Most of the mines have a "drain tunnel." This is an adit driven from some proximate gulch or cañon, to tap the vein for the purpose of carrying off the surface water that seeps from the upper levels to the horizon

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of the adit. The water pumped from the lower depths is likewise usually discharged through this drain tunnel.

Where the quantity of water to be hoisted is not sufficient to require a pumping plant, the water is raised from the sump at the bottom of the shaft. In vertical shafts buckets of various sizes and designs are used. Where the shaft is provided with guides and the ore is hoisted in cages, the bailing tanks are rectangular in form and are made to run upon these guides. These tanks are usually provided with safety cages similar in design to those used on the cages. A hinge valve at the bottom of the tank permits the automatic discharge of the water in the launders at the surface. A more expeditious method is to dump the tanks by the arrangement of the guides used with self-dumping skips. The tanks have a capacity of three hundred to eight hundred gallons. Where the hoisting is done through incline shafts, self-dumping skips are used to raise the water. At the Utica Mine six hundred and seventy-five gallons of water can be raised in a minute and a half, from a depth of five hundred and sixty feet, through a single compartment of the shaft.

Where the amount of water is too great to be handled by buckets, tanks, or skips, which is often the case where the water and rock must be raised through a single compartment of a shaft, a steam pump is very serviceable. A pump of this character is especially to be recommended in the preliminary stages where the developments of the mine are not sufficient to justify the erection of the far more costly system of the Cornish pumping plant. Steam pumps are also a valuable adjunct to the Cornish or to any other system of pumping plant, as they are very useful in emergencies. In case of accident disabling the Cornish pump, or in the event of the sudden influx of a great volume of water, the auxiliary steam pump might prevent the inundation of the mine, or of the lower workings at least. Compressed air is often used instead of steam. This is the case always where the pump is remote from the boiler.

Compound steam pumps, although the most economical of all types of steam pumps in the consumption of fuel, are seldom employed on account of their great first cost, preference being given to the Cornish system, when the erection of a large plant is necessary.

Non-rotary pumps without flywheels are used in preference to rotary pumps. Although the latter are more economical in power, they are too expensive and too cumbersome as compared with the non-rotary class to be advantageously employed.

The simple steam pumps are either horizontal or vertical. Both classes are used. The vertical pump is especially useful for sinking, on account of the facility with which it can be lowered or raised. By far the most important class of pumps used in this State is the Cornish plunger and lift pump. (Jackhead pump, also). For handling large volumes of water from great depths this system is superior with respect to economy in the use of fuel to pumps of any other design. The first cost of the plant is considerably greater than that of the plant of the steam pump. The lift pump is used to raise the water from the bottom of the mine to the lowest of the set of plungers. From the lowest plunger upwards, plunger pumps alone are used. The motion of the plunger or piston is imparted to it by the pump rods, which are placed in the shaft along the line of pump column through which the water is

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raised. The pump rod is composed of timbers from four to twelve inches square, joined together so as to form a continuous piece. This rod is connected with the balance "bob" at the surface. Intermediate balance bobs are likewise used at various points in the shafts. To the nose of this oscillating bob, the upper end of the pump rod is attached. The oscillating motion is imparted to the bob by a pitman, which connects the king-post of the bob with the pump wheel. To one side of this wheel the pitman is attached by means of a wrist pin.

A reciprocating motion is thus given to the pitman, which in turn actuates the bob, imparting to it, as before explained, its oscillatory motion. The length of the stroke imparted to the rods and thence to the plunger is regulated by the distance of the wrist pin from the center of the wheel. The length of strokes varies from three to eight feet and the number of strokes per minute varies from three to ten or twelve, depending upon the duty required of the pump.

At the inner end of the bobs, counter weights are placed in boxes attached to the bob for that purpose, to prevent the too rapid descent of the rods and to equalize the work of the engine at either stroke.

The pumping plant of the Idaho consists of three fourteen-inch pumps, five seven-inch pumps, one six-inch pump, and one four-inch pump. These pumps drain the mine to a depth of two thousand three hundred feet on the dip of the vein, or one thousand seven hundred in vertical depth.

The pumping system is the Cornish plant. To work these plunger pumps, there are eight hundred feet of ten-inch rods, five hundred feet of eight-inch rods, and one thousand feet of seven-inch rods. There are eleven balance bobs and angles in use.

In addition to the above pumps, the Idaho has five steam pumps to be used in case of breakage of pump rods, etc., of the regular plant. The pump is operated by one hundred miner's inches of water, under a pressure of five hundred and twenty feet.

PUMPING PLANT.

The pumps used at the North Star Mine belong to the Cornish system, and consist of the following plant: A sixteen-inch plunger at the 500-foot level; a sixteen-inch plunger at the 1,400-foot level; an eight-inch bucket and twelve-inch plunger at the 1,700-foot level, and a six-inch bucket or lift pump for sinking. The rods used are of the following sizes: Twelve by twelve from the surface to the 500-foot level; ten by ten from the 500-foot level to the 1,700-foot level; six by six from the 1,700-foot level to the 2,000-foot level. The average speed in summer is from three and one half to four strokes per minute; in winter, from seven to eight strokes per minute. Length of stroke, six feet. The vertical depth from the 2,000-foot level is six hundred and fifty feet.

At the Empire Mine the following pumps are used: Nine-inch plunger at the 300-foot level, throwing the water to the drain tunnel; fourteen-inch plunger and six-inch bucket at the 600-foot level; twelve-inch plunger and eight-inch bucket at 1,000-foot level; twelve-inch plunger and six-inch bucket at 1,300-foot level; eight-inch plunger and ten-inch bucket at 1,700-foot level; ten-inch bucket at 1,800-foot level; six-inch bucket to sink with. Size of rods, ten by eight inches from surface to 600-foot level; eight by eight from 600-foot to 1,400-foot level; six by six from

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1,400-foot to 1,900-foot level. Heavier rods are being introduced. The average speed of the pump in summer is five and one half to six and one half strokes per minute; in winter, eight and one half to nine and one half per minute. Length of stroke, six feet.

When the capacity of the pump column is limited, it may be increased by using a lift pump, operated by the pump rod upon its return out-of-door stroke. An inverted plunger pump may be used instead of the lift pump, and is preferable, owing to the fact that it is less liable to get out of order.

MINING FORCE.

The Idaho employs the following men in its mining operations: Four engineers, four landers, twenty-two carmen and shovelers, two drill or tool boys, three pumpmen, twelve timbermen, nine shaftmen, seventy-four miners, and two shift bosses and one foreman.

The North Star employs sixty-five to eighty miners, twelve to fourteen carmen, eighteen to twenty-five shovelers, fifteen to twenty-five contractors, fifteen to twenty-five tributers, three bosses, and one foreman.

The Utica Mine, of Calaveras County, extracts two hundred tons of ore in twenty-four hours. The stopes are carried from twenty to forty-five feet. No waste is hoisted from the stopes. Hoisting is done through a double compartment vertical shaft, from levels four hundred and forty to five hundred and forty feet deep. The stoping is done by air drills, five of which are used for that purpose. Water power is used. Dip of vein about 75 degrees to 80 degrees.

The Utica employs ten machine men, ten chuck-tenders, making twenty men working in stopes; eleven timbermen, twenty-two carmen and shovelers, and twenty surface men at the mine, *i. e.*, carpenters, engineers, blacksmiths, etc., aggregating seventy-three men at the mine.

WAGES.

Miners receive from $2 50 to $3; $2 50 is the sum paid in most of the central mining districts. In some mines "first-class" miners are paid $3, while the others receive $2 50. At Grass Valley $3 is paid to all miners working in the stopes; carmen and shovelers receive from $2 25 to $2 50 per shift; engineers and blacksmiths get from $3 to $4. Other surface labor averages about $2. Chinese, receiving from 30 to 50 per cent lower wages than white labor, are sometimes, though in but few camps, employed as shovelers, carmen, etc., and for surface work.

SHIFTS.

Two shifts, working ten hours each, is the common system in this State. Surface labor generally work twelve hours. Where speed is an object, three eight-hour shifts are sometimes employed.

CONTRACTS.

Where feasible, it is cheaper to have the work done by contract than by days' pay. In drifting, sinking, etc., contract work is generally from 10 to 30 per cent cheaper. In a few of the important mines the tribute system is used to advantage in stoping ground too poor to pay

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increase in depth, was evident, the temperature being so much dependent upon the circulation of the air as to obliterate any influence that would otherwise exist because of the difference in depth of the points of observation.

POWER DRILLS.

Nearly all of the more important mines have power drills. Air drills are almost exclusively used, steam being nowhere used in this State as the motive power of the drills.

While the direct application of steam as the power to drive the drills is far more economical than the use of compressed air, there are many serious objections to its use under ground, the chief of which is the excessive heat which its use causes when employed in confined or close places. In addition to this objection, there is a great loss of pressure in transferring the steam to the point of application, because of its condensation in the pipes en route to this point. Hardly more than 40 per cent of the power consumed in compressing the air to the required degree (usually sixty to seventy pounds per square inch) is utilized by the drill. This loss of power arises chiefly from the fact that none of the power expended in the compression of the air can be utilized, inasmuch as the air, when applied to the drills, does not act expansively. Power is thus wasted in the compression of the air by the transformation of this power into heat, which is subsequently lost by conduction and by radiation. Heat generated in the compression of the air is not only the result of loss of power directly, but is a positive disadvantage, for the reason that the air during compression in the cylinder is cooled in the various compressors used by the introduction of a spray of water into the cylinder, or by means of a flowing stream of cool water enveloping the cylinder. The loss through the heat arises from the cool contraction of the air and the consequent decrease of the tension of the air as it passes from the compressor to the air reservoir. The heated air, likewise because of its increased tension, due to the heat, reacts upon the piston, causing a resistance, and consequently far less of the power is applied to the piston. The friction of the compressed air passing through the valves also causes a loss of power. These, with the other causes before adduced, will account for the small amount of power utilized by the application of compressed air to the drills. In short, the power expended by the piston during the first part of its stroke is wasted in the compression of the air, since, as above stated, the air cannot be applied expansively to the drills. This loss is unavoidable. The latter part of the stroke, however, is utilized in driving the compressed air into a reservoir, under the pressure from which reservoir or receiver it is distributed to the drills. The lowest pressure in the transmission of the air from the receiver to the drills should not exceed one to three pounds per square inch for a distance of one thousand to two thousand feet, where pipes of sufficient diameter are used. Where pipes are too small, the loss due to friction may be very considerable. The proper diameter of the pipes will depend upon the number of drills used and the distance of the drills from the receiver.

In addition to its use as a power to drive the drills, the air performs a valuable service after it accomplishes the above work, when it is discharged in the drifts or stopes, or wherever it may be used, as exhaust air. In confined places, as at the face of drift for example, this feature

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when the ground is very hard, in which event double handed drilling must be adopted.

EXPLOSIVES.

Explosives used in mining in California are chiefly of two classes:

1. Those which explode instantaneously (or almost so) are known as quick or shattering compounds. Nitro-glycerine is a decisive type of this class.

2. The weaker compounds which explode more slowly and perform their work by trajection. This class is called slow disintegrating or rending compounds. Black powder is a prominent type of this class.

Explosives of the first class are, to a great extent, superseding the use of the weaker explosives of class two. In the first class the initial pressure is the maximum one, while in the second class the explosion proceeds progressively by combustion, and its gases gradually accumulate and reach their maximum pressure just before the resistance gives way. This is an important distinction, and determines the application of one or the other of the classes, or the adoption of an explosive of intermediate character in this regard.

The explosive principle, as is well known, in dynamite is primarily nitro-glycerine, consequently its explosive power is dependent on the percentage of nitro-glycerine present.

In order to increase the safety and the convenience of portability of nitro-glycerine explosives, an absorbent is used as the carrier of the nitro-glycerine. Originally this absorbent was of an inert character, consisting of Kieselguhr and infusorial earth found in northern Germany. This earth is composed of small diatomaceous shells. The porosity and absorbent quality by capillary absorption render it one of the best of the inert media.

Primarily, as we have seen, the function of the absorbents was to incorporate the nitro-glycerine so as to decrease its liability to explosion by accidental mechanical blows to which it would be exposed in handling it. This absorbent, by reason of its compressibility, forms, as it were, a cushion which deadens the effect of a blow imparted to the cartridge containing nitro-glycerine. As a result of this physical character of the admixture of earth and nitro-glycerine, the effect of concussion of an ordinary character was rendered inoperative in its explosive tendency, the explosive yielding to the blow by reason of the compressibility of the mass and thus averting the explosion.

In order to complete explosion, detonators are used, while powder may be used to detonate the dynamite. When the dynamite powders were first introduced black powder was used as a detonator, but, owing to the uncertainty as to its complete detonation, it is but rarely used at present, being almost entirely replaced by a glass compound called fulminates. Of these, the fulminate of mercury is now the most generally used. This is the best detonating agent.

The fulminate of mercury is generally mixed with a small percentage of gun cotton and chloride of potash—or other chemical substitutes—in order to make it more safe to handle. When wet it is pressed into copper capsules to further decrease the danger of transportation.

Many dynamite compounds employ a chemical absorbent which, being itself of an explosive character, enhances the efficiency of the compound. These compounds are likewise so made as to reduce the quantity and

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desired moment. This insures the safety of the men. The effect of the blast is likewise greatly increased by firing the charges simultaneously. It is superior to all other methods for firing charges under water.

Electrical fuse is an explosive compound placed in the circuit of an electrical current. There are two ways of passing an electrical current through this fuse: First, the current is generated by what are known as high tension machines; second, by low tension or "quantity" machines. High tension machines are more convenient to handle, and are better adapted to the use of miners unskilled in the use of batteries. It possesses several advantages, but one disadvantageous feature is the fact that perfect insulation is not assured. In low tension, or quantity fuses, perfect insulation is not required, but a greater sectional area of the wire is necessary than when the high tension system is used.

There are two kinds of exploders used in the high tension system, viz.: frictional electric exploders and magneto-electric exploders. When an electro magnet is used in a magneto-electric machine instead of a permanent magnet, the machine is known as a dynamo-electric exploder.

COST OF MINING PER TON OF ORE EXTRACTED.

1. *Cost of Dead Work to Open the Ground for Stoping.*—The cost of dead work is an item of great importance. By dead work is expressed all underground developments made to reach and open up the ore bodies for stoping the ore. Where the veins are small and the ore shoots are few and short, and where long tunnels have to be run through barren ground in order to reach the pay shoot, the item of cost of dead work is correspondingly great. The number of tons of ore extracted in mining operations is sometimes so small as compared with the number of tons of waste—rock to be removed in drifting and sinking—as to render the cost per ton of ore extracted too great to admit of profitable mining.

In the Plymouth Mine, of Amador County, the cost per ton of quartz mined for dead work was probably less than 10 cents. In the Plymouth the stopes were from thirty to fifty feet in width. Nearly all of the ground broken down in the stopes went to the mill. The shoot of ore stoped was from three hundred to four hundred and fifty feet long. Contrast these conditions with those of the North Star, of Nevada County. The vein in the latter mine has a width of but from one and one half to two feet; the vein is likewise flat, and frequently splits up, forming a hanging wall and foot wall vein four or five feet apart. Obviously a vein of this character requires the removal of much waste in the extraction of the ore. More than four tons of waste are blasted down for each ton of ore extracted. Consequently, the output of ore for each one hundred feet developed by shafts, drifts, and upraises (the cost of which work is charged against the account for dead work), is very small as compared with the output of the thirty to fifty-foot vein in the Plymouth. The cost per ton of quartz for dead work at the North Star is about $1 25 to $1 50. Cost of dead work at the famous Homestake of Dakota, is 20 cents per ton.

2. *Cost of Labor in Stoping.*—Mining men too frequently confound this item with the cost of mining, whereas, as will be seen, it may be but a minor part of the cost of mining. Where the vein is large, the ground soft, etc., the cost per ton for labor is, of course, less than where the converse is true. In large veins with air drills, often as much as from four

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mines. The general expenses and taxes of the Plymouth Consolidated during the year 1886 was about 25 cents per ton for one hundred and one thousand three hundred and five tons of ore extracted. The general, legal, and insurance expenses, and taxes at the North Star for the year 1889 was 72 cents per ton for seventeen thousand nine hundred tons of ore extracted. Obviously, when operations are conducted upon a large scale, the cost per ton for the above items is less than smaller operations.

8. *Contingent Expenses.*—This is an item which frequently figures high, but it is impossible to approximate the cost per ton.

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in any one lode claim is a parallelogram one thousand five hundred feet in length along the lode by six hundred feet in width, with parallel end lines; and in no case can either side line be more than three hundred feet from the center of the lode at the surface.

Thus, a claim may be restricted on one side by an adjoining claim to twenty-five feet of ground; the other side, being unclaimed ground, would give the claim but three hundred and twenty-five feet width of surface.

The locators of all mining claims made under the law, where no adverse claim existed on May 10, 1872, so long as they comply with the local and United States laws, have the exclusive right to the possession and enjoyment of all the surface included within the lines of their location, and of all veins, lodes, and ledges throughout their entire depth, whose tops *are within the surface lines, extended downward vertically.*

But their rights to such lodes terminate, like the right to the discovery lode, at the points where the plane of the end lines of the claim, extended downward vertically, cut such lodes.

Thus, the dip of the lodes in a claim may carry them outside the vertical planes of the side lines, but in no case does the claim extend beyond the vertical of the end lines.

The rights under this law are general as regards the title to all lodes within the surface boundaries, whether the claim is located since May 10, 1872, or previous to that date; provided, however, there was no adverse claim at that date.

A claim along the lode need not be a straight line, but is supposed to have as many angles as there are changes in direction of the lode itself; but the side lines must not be more than three hundred feet from the center of the lode at any point, and in all cases the end lines *must* be parallel.

Lands valuable for minerals are reserved from sale except as mineral lands, and although such lands may have been marked on the township plats and recognized for years as agricultural lands, the discovery of minerals in paying deposits makes it mineral lands, to be disposed of as such, providing the title be still in the Government. But the law expressly provides that no mineral rights are acquired by location until after the discovery of a vein or lode bearing mineral.

ANNUAL EXPENDITURE.

But a location is made valid by the discovery of a vein or lode at any time after the location, provided that such discovery is made before any rights are legally acquired to the ground by other persons.

In order to hold a claim located before May 10, 1872, the law requires an annual expenditure of $10 in labor or improvement on each claim of *one hundred feet* on the lode until a patent is issued; but where a number of such claims are held in common on the same vein, the aggregate amount for all the claims may be expended upon any one claim.

Claims located since May 10, 1872, require an annual expenditure for labor or improvement of *$100 for each claim,* whether it be fifteen hundred feet in length or less.

But where several claims, upon the same lode or adjoining, are held in common, and a general plan for working the group is contemplated, then the necessary aggregate expenditure for the group may be made upon

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same, and with it twenty-five feet of ground on each side of the newly discovered lode.

CROSS LODES.

When two lodes cross, priority of title governs, and such prior location shall be entitled to all the mineral contained within the space of intersection; but the subsequent location shall have right of way through the intersection for convenience of working the mine. When two lodes unite into one, prior location takes the entirety below the point of union.

TUNNEL RIGHTS.

Where a tunnel is run either for the development of a known lode or for the purpose of discovery, the owners of such tunnel have the right to all veins or lodes within three thousand feet of the face of the tunnel. on the line thereof, discovered in such tunnel, to the same extent as if discovered from the surface; and locations on the line of such tunnel of veins or lodes not appearing on the surface, made by other parties after the commencement of the tunnel, and while the same is being prosecuted with reasonable diligence, shall be invalid; but failure to prosecute the work on the tunnel for six months shall be considered as an abandonment of the right to all undiscovered veins on the line of such tunnel.

TUNNEL NOTICE.

The proprietors or projectors of such a tunnel, in order to avail themselves of all rights of this provision of law at the time the tunnel enters cover, should post *at its face* in a plain and substantial manner, a notice of their tunnel claim, the course or direction of the tunnel, its height and width, its location by course and distance, as near as may be, from some permanent and well known objects in the vicinity (in order to fix its locus), and the names of the parties claiming such tunnel right.

A copy of such notice must be filed with the Recorder of the district, as in the location of a mine, and with it a sworn statement of the owners, claimants, or projectors of such tunnel, setting forth facts in the case; the amount expended by themselves or grantors in work thereon; the extent of work performed, and that it is their intention to prosecute the work in good faith, and with reasonable diligence, for the development of a lode or the discovery of veins or lodes, as the case may be.

This sworn statement must be attached to the recorded copy of location, and kept on file by the Recorder for reference or inspection.

The "*face*" of a tunnel means the actual working face or point where the tunnel *entirely enters the ground*. A permanent stake should be set and a notice posted at this point.

These provisions are made to protect actual locators and constructors of tunnels in their rights of discovery of blind lodes against those who would be willing to profit by their labor and expense.

PLACER CLAIMS.

As in the case of lode claims, placers were formerly located and claimed according to local rules and regulations, varying from a few feet square of ground to hundreds of acres in one claim.

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Such old claims, where their boundaries can be proved either by records of location or by possession for the time required by the statute of limitations, are recognized by law, and patents issue in accordance with the boundaries of the original claim. But by Act it is declared that no location of a placer claim made after July 9, 1870, shall exceed one hundred and sixty acres for any one person or association of persons.

After May 10, 1872, not more than twenty acres shall be located by any one person, nor more than one hundred and sixty acres by any association of persons, so that it now requires at least eight persons to locate one hundred and sixty acres of placer ground; and a further requirement of the law of May 10, 1872, is that placer locations shall conform as nearly as practicable to the United States surveys when located upon surveyed lands.

No local regulation can restrict an individual to less than twenty acres of placer ground, but the locator may take less if he desires.

The same rule applies to placers as to lode claims: that the location must be marked plainly upon the ground, a notice of location posted, and such notice duly recorded.

If there is no District Recorder, then the record is made in the County Recorder's office.

A placer location simply holds the placer ground within the boundaries marked and described; a lode occurring in such placer claim should be claimed as a lode.

Hence, a placer location embracing a known lode should state that the claim is for the placer ground as well as the lode embraced.

This rule is recognized by the Department of the Interior, and in issuing patents for placer claims it is expressly stated that the title to known lodes does not pass with title to placer ground, for when known lodes exist, and the claimant of placer ground does not apply for the known lodes within his boundaries, the presumption is that he does not wish to purchase the lodes.

If there are no known lodes within the placer ground, of course the patent gives title to all the mineral within the boundaries of the claim.

The United States laws do not require annual expenditures upon placer claims; this expenditure or assessment work is regulated by the local or district regulations, which must be carefully complied with to give a standing in Court.

MILL SITES.

Any person owning a mine or a mill, desiring to secure a location for milling purposes, may locate a tract of non-mineral land, not to exceed five acres in area, in a compact form, by placing monuments at the corners and posting a notice describing the premises exactly as he would proceed to secure possession of a lode or placer claim.

The claimant of the lode may have embodied in one survey and plat the lode claim and mill site, even though they are not contiguous; and patent can issue for both together.

COAL AND IRON LANDS.

Coal and iron are not classed as mineral lands in its full sense, for the reason that in making grants to railroad companies Congress has enacted that it does not grant to such railroad company mineral lands,

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and then follows the statement that the term "mineral land" where used in said Act shall in no case be construed to include iron and coal lands.

So the railroad owns the coal and iron on its grant undiscovered at the date of granting; but following is the law which shows how coal lands may be acquired:

UNITED STATES STATUTES, REVISED, SECTION 2347. Every person above the age of twenty-one years, who is a citizen of the United States or has declared his intention to become such, or any association of persons severally qualified as above, shall, upon application to the Register of the proper land office, have the right to enter, by legal subdivisions, any quantity of vacant coal lands of the United States not otherwise appropriated or reserved by competent authority, nor exceeding one hundred and sixty acres to such individual person or three hundred and twenty acres to such association, upon payment to the Receiver of not less than $10 per acre for such lands where the same shall be situated more than fifteen miles from any completed railroad, and not less than $20 per acre for such lands as shall be within fifteen miles of such road.

SEC. 2348. Any person or association of persons severally qualified as above provided, who have opened and improved, or shall hereafter open and improve any coal mine or mines upon the public lands, and shall be in actual possession of the same, shall be entitled to a preference-right of entry under the preceding section of the mines so opened and improved; *provided*, that when any association of not less than *four* persons, severally qualified as above provided, shall have expended not less than $5,000 in working and improving any such mine or mines, such association may enter not exceeding six hundred and forty acres, including such mining improvements.

Claims of the above character must be filed by declaratory statement in the Land Office of the district in which the lands are situated, within sixty days after actual possession and work, provided the land is surveyed and open to entry.

If the lands are not surveyed, possession by actual work is the only safe title until it is surveyed, when the filing must be made within sixty days after the filing of the plat of the township with the Register of the Land Office. No one person, either individually or associated with others, can make more than one entry upon coal lands.

Coal lands must be paid for within one year from date of filing. Failure to comply with the provision forfeits the right to the land, and throws it open to entry by any other qualified person or association.

All coal lands must be claimed and filed on by legal subdivisions.

IRON LAND.

Where not on railroad sections, iron lands are treated exactly as gold lode or placer claims. Where located prior to May 10, 1872, the extent of area is governed by the local laws of the district. Where located since May 10, 1872, as a ledge or rock in place, one thousand five hundred feet along the lode and three hundred feet each side of the center of the lode, is the greatest extent permissible.

Where not found in ledge form, it is located in twenty-acre tracts to one person, or one hundred and sixty acres to an association of not less than eight persons, under like conditions as gold placer mines.

The same care must be taken in regard to placing of monuments at the boundaries, the posting of notice, recording of same, and in conforming to local laws and usages.

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DIGEST OF DECISIONS RENDERED BY THE FEDERAL AND STATE COURTS, AND BY THE LAND DEPARTMENT.

ABANDONMENT.

1. Abandonment by intention, is where one purposely quits work and assessment on a claim.
2. Abandonment in law and fact, is where one has failed to keep up assessments, whether intentional or not.
3. When a person abandons a claim, he has the undoubted right to remove his improvements, tools, buildings, and extracted ore.

ADVERSE CLAIM.

Only an interested party can claim adversely.

Foreign companies cannot set up adverse claim to non-patented ground.

The silence of a first locator, when a subsequent locator applies for patent, is equivalent to acknowledgment by first locator of the right of subsequent locator.

An actual survey must be made of the entire adverse claim.

A conflicting claim already patented cannot delay an application for patent as an adverse claim, but the ground in conflict will be excluded from the last patent.

A public highway is not an adverse claim.

Failure to file an adverse claim within the time and in the manner provided by law, is equivalent to estoppel before the General Land Office, and remedy is only in the Courts.

AGRICULTURAL CLAIMS.

Lands valuable for mineral are reserved from sale, except as otherwise provided by law, and whether lands are mineral or agricultural is a matter of proof, regardless of past notoriety.

In contests between mineral and agricultural claimants it is necessary for the mineral claimant to show that valuable mines have been actually discovered on the land in dispute.

Title to known mines does not pass with an agricultural patent, but an agricultural patent holds mines discovered subsequent to such patent.

ALIEN.

Aliens cannot locate or hold mining claims against a citizen, or one who declared his intentions to become such.

If an alien locates a claim, and transfers his rights to a citizen before another acquires any rights in the claim, the one receiving such claim from the alien will hold against all others. That is, his claim is good because he acquired it before any other citizen.

APPEAL.

Appeals from decisions of Registers and Receivers of Land Offices are made to the Commissioner of the General Land Office within thirty days from date of notice of decision by Register and Receiver.

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Appeals from the decision of the Commissioner are made to the Secretary of the Interior.

APPLICATION FOR PATENT.

The locator or claimant of a mine becomes the assignee of the United States, and so long as he complies with the laws, general and local, he has exclusive right to the ground claimed and the minerals therein, and he need not get a patent unless he thinks proper.

Where an association of persons, unincorporated, apply for patent, the notices, certificate, and all other papers should give the names of all the applicants.

Where a party applies for a patent to a placer claim embracing one or more lodes, it will be necessary to show such lodes by survey, whether belonging to the applicant or to other parties. Placers are sold at the rate of $2 50 per acre; lodes and mill sites at $5 per acre.

When two applications conflict, a compromise may be made by the respective claimants, and the Surveyor-General will order a survey of the compromise line.

Where a placer claim is on surveyed land and located by legal subdivisions, no survey or plat will be required in application for patent. Proof of improvements, in each case, can be made by parties familiar with the ground.

There is no law for selling quartz mines by legal subdivisions.

Applications for claims lying partly in two land districts should be made to the office of the district in which is located the principal workings. A copy of the plat and notice should be posted in both land offices.

Two or more lodes cannot be embraced in one application for patent, except for placer claims embracing two or more lodes, or in the case of a consolidation of different lode claims under one group.

A placer and lode claim not contiguous, or the lode entirely without the placer location, cannot be embraced in one application for patent.

Where several placer tracts, not contiguous, but in the near neighborhood, have been surveyed by United States authority, they may be embodied in one application for patent, but this cannot be the case when they are far separated.

CEMENT AND CLAY.

Cements of all kinds may be considered as placers, and located according.

CINNABAR.

Cinnabar claims can be entered only as lode claims, never as placers.

CITIZENSHIP.

No distinction under the mining laws is made between citizens and those having declared their intention to become such.

COAL.

Claimants to coal lands have no right to follow their vein or coal bed under adjoining land.

Coal is not classed as mineral in railroad grants, and consequently belongs to the railroads when found in their odd sections.

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DIAGRAM A

Shows how to turn a right angle by measurement, and it is a very convenient rule to remember that the dimensions 3, 4, and 5, or any multiple of those numbers, as 6, 8, 10, or 30, 40, 50, etc., when forming the three sides of a triangle, always make it a right-angled triangle.

This rule is useful for laying out an end line where it is desirable to make it perpendicular to the lode line; *e. g.*, measure from A along line of lode forty feet to H, make IA equal thirty feet, and IH fifty feet, and the line through AI will be perpendicular to the line AH.

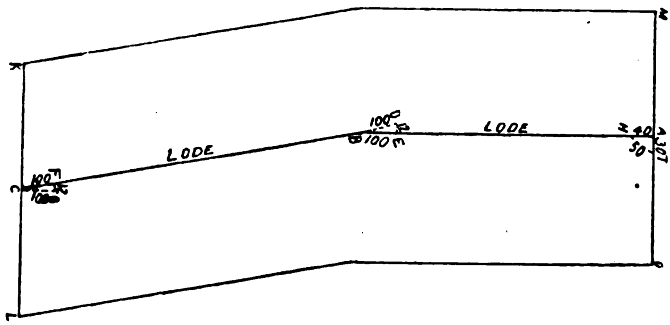

Diagram A.

Should it be necessary to make an angle in the claim, as shown on this diagram at the point B, in order to lay off the other end line parallel to the first AI, measure some convenient distance along the lode, say one hundred feet, as BE, and find the point D one hundred feet from B in the line CB produced; measure DE, which we will suppose in this case is twelve feet; now, when the point C is reached at the extreme end of the claim, it is desired to lay out the end line KCL parallel to end line MAO; to do so, measure CF equal one hundred feet, FG equal twelve feet, and CG equal one hundred feet; then will the line CG be parallel with AB, and a perpendicular to CG (laid out as directed above) will be parallel to MO.

Too much care cannot be used in the location of claims and a thorough understanding of local as well as general mining laws.

Let the boundary monuments be large and plainly to be seen; this fills the requirements of the laws, and prevents an adjoining locator from crowding.

It often happens that lodes of ore cross each other, and as one location can only cover one lode, it follows that the cross-lode is open to location.

DIAGRAM B

Shows the lode AB as located, with its proper amount of surface ground.

Subsequently the lode CD is found crossing the former lode at G. This makes a conflict in favor of the first location AB, as regards surface ground, but the law provides that the lode CD shall have a strip of surface twenty-five feet wide on each side of the lode through to the other claim from F to E, at which points the surface may widen again to its location width.

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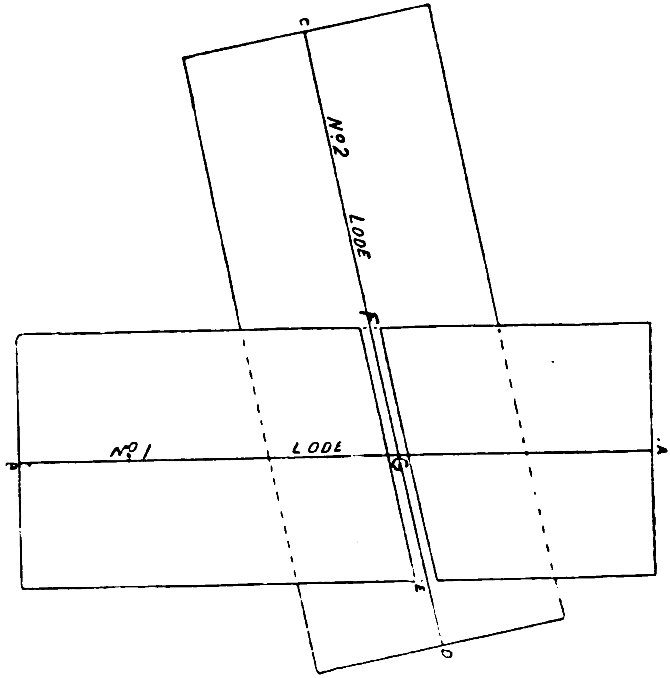

Diagram B.

This law holds good so long as mine No. 1 is not patented; but if No. 1 receives patent before the discovery of lode No. 2, of course it holds all mineral within its boundaries.

Should No. 2 acquire no rights until No. 1 had been patented, then, of course, No. 2 abandons all claim to the ground in conflict, and holds its own ground in two separate tracts.

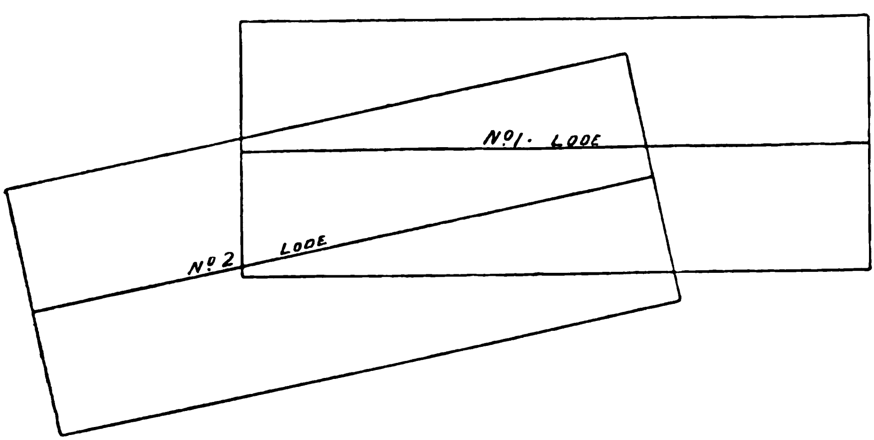

Diagram C.

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DIAGRAM D

Shows an excess in location, how the survey may be made, and the position of the location corners.

DIAGRAM E

Shows a deficient location, etc., each location call being for one thousand five hundred feet.

In each of these cases the location monuments are marked Loc. These diagrams illustrate the way a final survey will fix the boundaries, as well as the necessity for a careful first location; in one case. the owner claims more than belongs to him; in the other, he loses ground that might be very valuable.

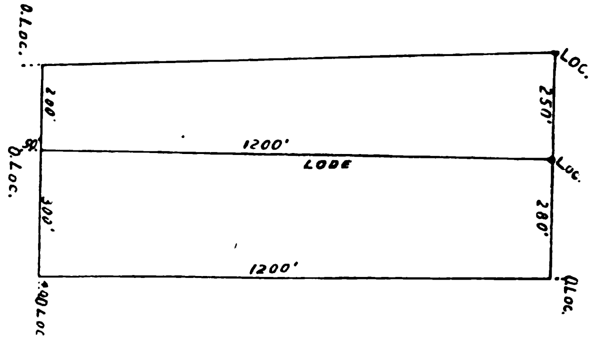

Diagram E.

All surveys of mining claims must be connected from one corner to a corner of the public surveys, if there are any within two miles. If there are no survey corners to connect with, then a mineral monument must be established within one hundred chains, and connection made with that.

The site for a mineral monument should be chosen with regard to prominency and safety from destruction by the elements, landslides, etc., as subsequent surveys will be connected with it when coming within the limit of distance.

Survey of mining claims, when crossing section lines or lines of surveyed mines, must show connection with such surveys, and permanent monuments must be established at such intersections.

Where a surveyed mine or an agricultural claim conflicts with the mine being surveyed, a survey of the part in conflict must be made and field notes thereof returned with the notes of the mine proper.

In addition to the above connections required, it is also required to connect a corner of the mine with a corner of all nearest surveyed mines (approved) within a distance of twenty chains.

DIAGRAM F

Shows the manner of surveying a claim in conflict with another mine, a mill site, and proper connections to a neighboring mine, and section lines.

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carry on this ash bed a burden of coal more than two feet in depth. This gave a very poor quality of gas.

All difficulties were overcome by charging the producer with Rock Spring (Wyoming) nut coal. The ash of this lignite sinters slightly. and carried easily a burden of four to five feet in depth.

Running a producer with a bituminous lignite, more or less tar and soot is deposited in the pipes. The former is removed by tapping; the latter by cleaning the pipes occasionally. Hence, the pipe-lines should be made accessible, and of such diameter that cleaning is not required too often. One man in an eight-hour shift takes care of the producer and the Stetefeldt furnace. A helper in the morning shift removes the ashes, and assists the furnaceman in barring out the producer.

ECONOMICAL RESULTS.

For firing the Stetefeldt furnace and the rotary driers, sixteen cords of wood were consumed in twenty-four hours at the Marsac mill for drying and roasting seventy tons of Daly ore. The cost of wood delivered at the woodyard was $5 per cord; hauling wood to the mill, $5 50 per day. The labor of three men in twenty-four hours was required for firing the rotary driers.

Since the introduction of producer-gas the consumption of Rock Spring nut coal is seven and one half tons per twenty-four hours, at $4 75 per ton delivered at the producer.

The total saving per day figures up as follows:

Saving in cost of fuel	$44 38
Saving in labor—two men at $3	6 00
Saving in hauling wood	5 50
Total	$55 88

To this must be added interest on the capital invested in the wood, of which a year's supply, or about six thousand cords (value, $30,000), was generally kept on hand. Now, the stock of coal on hand need not exceed two hundred tons (value, $950), just sufficient in case of a railroad blockade.

Finally, it was but natural to expect that, with the uniformity and great regularity of gas fire, an improvement in roasting should take place.

The Daly ore, being at present almost free from sulphurets, requires a very heavy fire in chloridizing roasting. During the first six months of 1890 the chlorination tests of the roasted ore averaged 90.7 per cent. Since the introduction of gas fuel the chlorinations rarely drop below 92 per cent, and reach 94.5 per cent.

There is no doubt the introduction of gas fuel in silver mills will now make rapid progress, and I have already received orders to design a gas plant for a large mill in Colorado. Gas will be introduced at the Ontario Mill, Park City, as soon as the large supply of wood now on hand has been consumed.

In conclusion, I will say that I can recommend the producer made by the Taylor Gas-Producer Company, of Philadelphia, to all who contemplate introducing gas for metallurgical purposes.

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forms a sharp and well-defined line of demarkation between the arid region and the rich and fertile western slope of our county.

The summit of this Peninsula Range is usually clothed with forests of oak and pine. The western slopes are thickly overgrown with a varied vegetation, the valleys supplied with timber and water in a greater or less degree. Not so on the eastern or desert declivity of the mountains. The precipitous walls of rock, hundreds and often thousands of feet in height, present small inducements for vegetable life, and the less precipitous slopes are but slightly less devoid of botanical forms.

It is in the mighty chasms or cañons, eroded by the still active, tremendous forces of Nature, that the botanist has to look for his richest harvest. Some of these cañons, with walls three thousand feet or more high, contain scenery that for beauty and grandeur would rival even the Yosemite. Groves of the queenly Washington palms, growing with tropical luxuriance beside quiet brooklets, rival in beauty and novelty the giant sequoia groves of our State.

During June and July, 1888, the writer made his first exploration of that portion of the Colorado Desert that lies in San Diego County, traversing the northern arm of the great basin from San Felipe Valley, by Borrego and Fish or Indian Springs to Salton; and thence into the Chuckawalla Mountains, where the Pacific Mining District has been organized. The main object of this trip was the examination of various gold, silver, and lead mines which had been discovered in the district, for a gentleman who was largely interested in their development.

This district is still practically unknown except to a few interested parties. As it has, I believe, never been visited by any member of the staff of the California State Mining Bureau, I will give a brief account, for which I am largely indebted to memory. My field notes are, unfortunately, not. by me, hence I am obliged to omit many details that might be of interest.

THE PACIFIC MINING DISTRICT.

This mining district is in San Diego County, and lies about thirty miles north of the Southern Pacific Railway. The nearest railway station is Salton, six hundred and thirty-seven miles from San Francisco. As organized, the district is some twelve by thirty miles in extent, but the mineral-bearing region is not thus limited. Perhaps no other county in the entire State of California possesses as large bodies of auriferous and argentiferous ores of as high an average grade as are to be found within the boundaries of this mining district. A broad arroyo furnishes a most excellent natural road from the railroad to the mines, and the grade is quite easy and uniform. The Cuyamaca Railroad survey through this pass is less than five miles away from the leading mining claims.

Good ironwood, mesquite, and palo verde wood can be cut and hauled to the mines at an average cost of $4 per cord. An abundance of good pure water has been developed in several of the arroyos around the mines, showing conclusively that no difficulty will be incurred in mining from the lack of water. The water has been developed by blasting in the rocks that form the bedrock of the arroyos, but as yet no water has been developed in any of the mines. This augurs well for the inexpensive working of the mines in the future.

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Dr. Remondino states, in the "West American Scientist" for August, 1890, that "sunstroke, heat diseases or accident, and hydrophobia, are here unknown (at San Diego), and the highest temperature of the foothills, or even of the desert—the latter reaching the enormous or excessive heat of 140 degrees Fahrenheit—is remarkably well borne, as workmen in the New Liverpool Salt Works, in the sink of the Colorado Desert, three hundred feet below sea level, in this county, labor in its summer heat with less annoyance or discomfort than that experienced by ordinary harvest hands in the fields of the Mississippi Valley. Here the heat, for some reason, has neither the enervating or the morbific effect of the same element in the East, as a degree of temperature that in New York would be prostrating and followed by accident, and a great mortality among the young and the aged, will on this coast hardly cause a feeling of discomfort."

My collection of mineral and rock specimens was secured at a time when the thermometer registered as high as 140 degrees Fahrenheit in the Pacific Mining District. There were several hundred pounds in weight which I had to pack over the trails—often two miles or so in length—on my back; yet I was not in any way inconvenienced by the heat, the warm, dry breezes being rather invigorating and healthy.

Considering the extent and richness of the ore deposits on this range of mountains, there seems to be no valid reason for their not being fully developed.

THE POOR MAN'S MINING DISTRICT.

This district lies southeast of the Pacific Mining District in the same range of hills.

Another mining district has been organized in the region of the Colorado River, to the northeast of the Poor Man's District, but I have no data concerning it at this writing available. It is said to contain valuable gold mines and extensive deposits of copper ore, at present scarcely available from the inaccessibility of the region where they are located.

MINERALS OF THE COLORADO DESERT.

Many of the mineral substances which have been collected by the writer on his various explorations in the desert have not yet been identified, but the following list of species reported from that region has been compiled. Mr. Hank's list of California minerals in the sixth report of the California State Mineralogist has been freely drawn from, as will be seen by the references given.

ACTINOLITE.—Abundant evidently in the hills near Salton, around Dos Palmas Springs.

AGATE.—A so called water agate is abundant at Cañon Springs. True agates are occasionally found on the surface of the desert in the drift. With the agates are often found beautiful chalcedonies and other stones of almost gem quality.

ALABASTER.—Gypsum is very abundant in portions of the desert, and some of it is nearly or quite of the quality of alabaster.

ALUM.—"At the mud volcanoes, San Diego County, and at numerous locations, as an incrustation on rocks."—*Hanks*. Held in solution by the water in the Dos Palmas and other springs, and deposited as an incrustation on the soil around them.

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eral from the mountains of Baja California, but whether from the desert region or from the western slope, the finders never could inform me, as they had paid no attention to it at the time of discovery, not knowing the mineral or its value.

CUPRITE.—"Lost Mine, thirty miles west of the Colorado River." Found sparingly in the Pacific District.

DOG-TOOTH SPAR.—Carrizo Mountain.

EPIDOTE.—Occurs near Ballena on the western slope of the mountains, a locality in this county worthy of record. Very fine radiating masses of this mineral were found in 1889, near the Alamo Mines, in Baja California; also, near the seacoast at San Ysidro.

FELDSPAR.—Numerous varieties occur near Mountain Springs, on Carrizo Mountain, and in other localities; some varieties of very fine quality.

FLINT.—Pieces occasionally found in the drift on the mesa-like plains of the desert.

GALENA.—Not rare in some of the mines in the Pacific District.

GARNET.—None of gem quality have yet been found on the desert, but millions of small size and inferior quality are found in the granite rocks and washes on the western borders of the basin. They were invariably found in washings for placer gold in this region.

GOLD.—Gold is found in quartz in many places on the eastern slope of the Peninsula Range of mountains, throughout the Chuckawalla Mountains, and in the low ranges of hills or mountains that diversify the surface of the broad plains of the great basin.

Several quartz mines have been located in the Jacumbe Valley during the past year, the owners of which are greatly encouraged with present prospects. Gold has been found in small quantity on the Carrizo Mountain, but no developments have yet been attempted.

Scarcely a quartz ledge in the Chuckawalla Mountains that will not yield a color to the industrious prospector, and many of these undeveloped mines will doubtless prove bonanzas to their owners in time. The reader is referred to the remarks upon the Pacific and Poor Man's Districts for mention of the leading mines that have thus far been even partially developed.

Wherever the prospector has used his pan on the mesa-like formations bordering the depressed basin, he has been rewarded with at least a color of placer gold. In every wash or ravine through the Chuckawalla Mountains, I am informed, gold has been found whenever sought with intelligence. In the bottom of Coyote Wells traces of gold have been found, and everywhere on the surrounding benches, but has as yet not been found in any place in sufficient abundance to warrant extensive operations.

In the Cocopa Range of mountains, south of the United States boundary, the Mexicans have found steady employment for some months past in apparently extensive placers. They claim to have been only moderately repaid for their labor, but as the miners at work in that locality are nearly or quite all outlaws of the Mexican Government, they presumably cannot do better than stay with these diggings.

The lack of an abundance of water for such operations, and other difficulties in the way of placer mining, will doubtless retard its development, for the present at least, in this inhospitable region.

GYPSUM.—Selenite, satin spar, and massive gypsum are abundant in

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SELENITE.—"Dos Palmas Station, Southern Pacific Railway." (See gypsum.)

SULPHUR.—"At the mud volcanoes, described in the Second Annual Report of the California State Mineralogist." In the Cocopa Mountains a very great deposit of sulphur has been discovered. These Cocopa Mines are about sixty miles south of the United State boundary.

TALC.—Coyote Wells; associated with other minerals.

THINOLITE.—"Colorado Desert."

TOURMALINE.—Schorl is one of the most widely distributed minerals in the world, and occurs in many localities in San Diego County, usually in feldspathic veins, on either side of the Peninsula Range.

WULFENITE.—Abundant in the Champion and Opulent Mines, Pacific Mining District.

BUILDING STONES AND MATERIALS.

The Peninsula Range of mountains, bounding the Colorado Desert on the west, possesses a rich variety of the choicest of granite, marble, and sandstone, unsurpassed in quality for building purposes. Some of these varieties are exceedingly beautiful, but are still practically unavailable from their comparative inaccessibility.

The surface of the desert is strewn with fragments of marble for a large portion of its area. These are worn and beautifully polished or sculptured by the drifting sand, until each is in itself a natural ornament. Da Costa, in his "Natural History of Fossils" (1757), page 197, says that "yellow marble was more esteemed by the Romans than all other varieties." Some of the delicately tinted pink, yellow, and variegated marble specimens from this region would lead us to indorse the taste of these ancient connoisseurs.

Aside from the marble and limestone so abundant in this section, we find immense quarries of red and brown sandstones worthy of entering into the construction of the finest of palatial homes.

The following are the principal species of rocks found on the desert which may become useful in building construction:

Marble and limestone, in different grades.

Cement rock.

Pumice.—Abundant in the great basin.

Gypsum.

Asbestos.

Porphyry, lava, and other volcanic rocks.

Sandstone; red, brown, and gray.

Gneiss, granite, and other granitic rocks.

Dunnite.—"From Cargo Muchacho Mining District, San Diego County. This consists of three distinct minerals—olivine, magnetite, and a micaceous mineral, unknown." (See Sixth Annual Report of the State Mineralogist, Pt. I, pages 32–3.)

Breccia.—Suitable for building purposes.

Clay.—A variety of clays, suitable for a great number of uses, exist in large deposits of as great a degree of purity as could be desired. But little attention has naturally been given to these natural resources of our county. That these deposits will prove a source of wealth in the future cannot be doubted.

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material and data, and the acquisition of a wider acquaintance with the subject, I must be permitted to change my present views, though the facts here recorded can never change.

THE QUATERNARY PERIOD.

The geological problems which confront us in the study of the great basin demand that we shall know something about the adjoining regions —Arizona, Sonora, the Gulf of California, and Baja California, as well as of the territory north and west in our own State. While the mineralogist may be satisfied with the various inorganic substances before him, and a knowledge of their chemical constituents, the geologist must pay still closer attention to the often indistinct organic remains in the rocks for suggestions as to their past history. To even approximately interpret the geological horizon from the testimony of the rocks, requires a knowledge of the characteristic features of the fauna and flora of the present day, as well as of the geological periods of the past.

"The region of country drained by the Colorado and its tributaries is about eight hundred miles in length, and varies from three hundred to five hundred miles in width, containing about three hundred thousand square miles."—*Powell.*

It is with the molluscan fauna of this large drainage area that we now have to do, in considering the Quaternary fossils everywhere distributed over the surface of the desert basin.

Dr. Robert E. C. Stearns read a paper some years ago before the California Academy of Sciences, entitled, "Remarks on Fossil Shells from the Colorado Desert," which was published in the "American Naturalist," XIII, 141–154 (March, 1879). His remarks were based on a lump of clayey sediment from near the bottom of a well sunk by the Southern Pacific Company at Walter's Station from a depth of about forty feet. This lump contained specimens of several species of fresh-water shells, *Physa humerosa*, *Tryonia clathrata*, and *Amnicola protea*. The surface of the desert where this well was sunk is one hundred and ninety-five and fifty-four hundredths feet below sea level.

At Salton, a station a few miles farther east, on the Southern Pacific Railway, these, and other fresh-water and marine shells as well, are found in countless myriads on the surface of the plain, which evidently once formed the bottom of an extensive lake or series of lagoons. This portion of the desert is generally designated as the Dry Lake. Salton is two hundred and fifty feet below sea level, and a part of this Dry Lake is depressed over three hundred feet. Along the shores of this lake these fresh-water shells are drifted into windrows in places where they may be scraped up by the quart.

In addition to the *Physa humerosa*, *Tryonia clathrata*, and *Amnicola protea* that were found in the well, *Amnicola loginqua*, *Anodonta Californiensis*, *Planorbis ammon*, and several marine species of shells were detected among this shell debris.

The desert is strewn in like manner, or in a less degree, with these same fresh-water shells as far south at least as the United States and Mexican boundary, along the course of New River especially. The whole of this area is probably below sea level.

Along the eastern base of the San Jacinto Mountains, an old beach-line is well defined, and can be easily traced for miles and miles from the line

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water lagoons, somewhat as Dr. Stearns has suggested. As the sea changed to brackish water lagoons, the marine fauna gradually disappeared until the last few survivors, like *Solecurtus*, ultimately perished, mingling their exo-skeletons with the empty homes of the fresh-water shells which were annually brought down by the Colorado, gathered from widely separated portions of the territory it drained.

With the annual freshening of the water, the fresh-water shells thus transported for life by the Colorado gradually were able to survive from one season to another, until the conditions finally proved especially adapted for them. The following instances of the rapid multiplying of river and pond snails, in this connection, and as illustrating some problems of geographical distribution, will be of interest:

SOME OBSERVATIONS ON FRESH-WATER SNAILS.

At Sauzal, a ranch situated on Todos Santos Bay, Baja California (about one hundred miles south of San Diego by wagon road), an American erected a windmill some years ago to facilitate the irrigation of his fruit trees and garden. He banked up the earth around a little square in his garden where the surplus water was allowed to flow. An artificial pond was thus created, which probably was seldom, if ever, allowed to be dry, as it was utilized for watering stock and as a duck pond. I first became acquainted with this place in the spring of 1882. In April, 1885, I was surprised to find the muddy bottom and sides of this little pond lined with thousands of tiny living pond snails, about which the following note was printed in the "West American Scientist," I, 74 (October, 1885):

Limnæa humilis was collected by the hundreds in April, 1885, in a small artificial pond in the vicinity of Todos Santos Bay, Lower California. The pond was near ten years old, a few inches deep, and about six feet across, fed by a windmill from a well twenty feet deep. For miles there is no surface water naturally, and it was a great surprise to find this mollusk in such a location. How came it there?

How such numbers of this snail came to exist in this locality will always remain a mystery. The species, though rarely detected in Southern California, is of very wide distribution in Europe and America. Transplanted through some natural agency—possibly through the eggs adhering to the legs or feathers of the ducks—the species found the environment favorable to rapid increase. It is certainly an interesting fact to note in connection with the study of geographical distribution.

In countries where the ponds and streams are perennial in character, it is comparatively easy to account for the presence of the various members of the molluscan fauna. Many of our Californian streams are periodical in their flow, and few of the lagoons of Southern California are known invariably to withstand the extreme droughts to which they are subjected.

In April or May of the present year (1890), I was surprised to observe a multitude of fresh-water snails in a little creek near San Diego—usually dry, and never running except for a few months during the winter season. These snails were *Physa distinguenda* and *Limnæa adelinæ*, two species, I believe, peculiar to Southern California.

At this writing these snails are dead, and thousands of their empty homes are bleaching among the dry stones, or entombed beneath a thick mat of fresh-water algæ which choked up the stagnant pools as the water-

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a portion of the time and dry the remainder, and was once, apparently, an extensive marsh or shallow lake."—*Gould.*

Less abundant than *Amnicola protea*, but by no means rare on the desert. This species has been found living in Utah by H. Hemphill. Dr. Cooper credits it to the Quaternary of Lahontin Basin, Lassen County, and of Nevada.

AMNICOLA PROTEA Gould, l. c., V, 129.—Gould's name is said to have had actual priority of publication over Conrad's *Melania exigua*, which is treated by Binney and others as a synonym. Binney refers the species to *Tryonia*. These fresh-water forms need a careful revision. This is credited to Utah in a living state, and I have found what was referred to this species in the Dos Palmas Springs, near Salton. What is referred to this is by far the most numerous of all the fossil shells found on the desert, and, though one of the smallest species, its numbers are so great as to exceed the others in bulk as well.

TRYONIA CLATHRATA Stimpson.—Shell elongated, narrow; apex of spire acute; sutures deeply impressed; whorls eight, with generally about twelve longitudinal ribs crossing them, sometimes crossed by revolving striæ or ridges, and angulated in the middle; aperture rounded oval, very small; diameter, 1.5; altitude, 5 millimeters. Dry Lake, Colorado Desert. Specimens bearing this name in my collection and in the State Museum from the Colorado Desert, are identical with *Amnicola protea*. Specimens from Utah, received through the kindness of Dr. R. E. C. Stearns, show this to be a very distinct species, however, though I have as yet failed to identify it from the Colorado Desert—the original locality whence came the types.

TYRONIA EXIGUA Conrad.—Southern Utah, living. "Quat., Colorado Desert."—*Cooper*. This is *Amnicola protea*, according to most conchologists. Conrad's *Melania exigua*.

TRYONIA PROTEA Gould.—See *Amnicola protea*.

GNATHODON MENDICUS Gould.—"Colorado estuary to Mazatlan, Mexico, living. Quat., Colorado Desert."—*Cooper*. Originally found by Dr. Le Conte north of Carrizo Creek. I have a specimen, probably this, from near Salton.

SPHAERIUM.——?—Binney, in "North American Land and Fresh-Water Shells," Part II, page 71, mentions a Cyclas from the Colorado Desert, collected with the other fresh-water shells by Wm. P. Blake.

MELANIA EXIGUA Conrad, Proc. Phila. Acad. Nat. Sci., VII, 269 (February 1855).—The following is a copy of Conrad's original description: "Turreted; volutions eight, disposed to be angulated and somewhat scalariform above; cancellated, longitudinal lines wanting on the lower half of the body whorl; columella reflected; aperture elliptical. Length, one fifth of an inch. Colorado Desert, California.—*Dr. Le Conte*. The specimens are numerous and of a chalky whiteness, showing that they are all dead shells."

This has been treated hitherto as a synonym of *Amnicola protea* of Gould, but it may be necessary to reinstate the species, as several forms exist under the latter name.

PHYSA HUMEROSA Gould, l. c., V, 128 (February, 1855).—Types from the Colorado Desert fossil. Found living in the Colorado River, in Pyramid Lake, Nevada, in the "Pecos River," and evidently the same form in the Dos Palmas Springs, Colorado Desert. Reported from the Quaternary near Carson, Nevada. It is virtually only a form of *Physa*

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thing like a "dry bog," across which man may not venture without danger of disappearing beneath the surface at any step.

We thus see that it is only within very recent years that this region has actually become a desert in reality. Having noted the capacity of the fresh-water shells for becoming widely distributed geographically, and their remarkable fecundity under favorable conditions, we need no longer wonder at the immense numbers of these shells that are now strewn over the surface or imbedded in its alluvial soils.

Just south of the United States boundary line a barren range of rugged hills extends southward towards the Gulf of California. This is the Cocopa Range of mountains, in which valuable mineral deposits are known to exist. The most northern of the range is distinguished by the name of the "Signal" Mountain, from the top of which the Cocopa Indian once lighted his signal fires.

To the west of Signal Mountain there lies the dry bed of an almost mythical lake—the Laguna Maquata, whose waters are invariably described on the Mexican maps as *muy salada* ("very salt"). Very little reliable information concerning this region is obtainable. In 1884 the lagoon is known to have been a very respectable body of water, from the overflow from the Colorado in that year, which was divided between the New River and the Laguna Maquata Districts.

Thousands of fish are said to have sported in its depths—many of the fish "exceeding two feet in length." In February, 1890, this extensive lagoon was as dry as the surrounding country, with only a small pool of brackish or salt water at its point of lowest depression, connected with other small pools to the southward by muddy, inapproachable sloughs. Along the banks of this defunct lake were numerous remains of the unfortunate fish—all that the hungry coyote had spared, which my friend, Dr. C. H. Eigenmann, has identified for me as having belonged to the mullet (*Mugil Mexicanus*).

Along the bottom of the lagoon were found numerous examples of fresh-water shells, the same species of *Physa* and *Planorbis*, and the *Anodonta*, as occur in the Dry Lake.

A salt spring is said to exist in the bottom of this lagoon, but this is contradicted by others. Others still claim that it is connected with the Gulf of California, but I saw no indications of such being the case. Apparently the history of the Colorado Basin known as Dry Lake, is being repeated in Laguna Maquata to-day, though on a somewhat smaller scale.

I am informed, on apparently reliable authority, that numerous fish remains exist in a portion of the Dry Lake that I have not yet visited. It will be interesting to learn whether they belong to the same species as the Lake Maquata remains. One of the problems which confront the geologist at this stage is the presence at Salton and other points of marine mollusks associated with the fresh-water shells, all of apparently the same age and in the same stage of preservation.

Solecurtus and *Anodonta*, *Cylichna* and *Amnicola*, seems like a strange association of genera. This brings us to the beginning of the Quaternary period, or the close of the Pliocene age. The two are so closely associated that it is hard to draw a line between them.

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THE PLIOCENE AGE.

That the Gulf of California extended to the base of the San Jacinto and San Bernardino Mountains during this age is plainly proved by the fossil shells which we find. The following is a list of the species thus far known to the writer from this region belonging to the Pliocene:

Ocinebra Poulsonii Nuttall.—Dr. R. E. C. Stearns informs me that he has this species from Indio. Living at San Diego to-day, and probably belonging to the gulf fauna as well.

Olivella biplicata Sowerby.—In the museum of the California State Mining Bureau there is a tray of fossil shells labeled "Colorado Desert, San Diego County, California.—*Albert T. Lee.*" Among them was an *Olivella*, which I very doubtfully refer to this species. Considerably smaller than *O. biplicata*, I presume it to be, perhaps, a gulf species with which I am unacquainted.

Conus Californicus Hinds.—In the same tray as the last; State Museum.

Nassa perpinguis Hinds.—In the same tray with the last; State Museum.

Nassa Cooperi Forbes.—State Museum, with the last.

Macron ——?—State Museum, with the last.

Lucina ——?—Near Carrizo Creek; "Resembles *L. Californica* closely." —*Orcutt*, 1890.

Cylichna ——?—"Associated with *Amnicolæ* and other fresh-water shells, from Salton."—*Orcutt*, 1888. Resembles *C. inculta* somewhat.

Solecurtus Californianus Conrad.—"Associated with fresh-water shells; Salton. Abundant."—*Orcutt*, 1888.

Probably this list will be greatly enlarged when the desert is more fully explored. Several other species of mollusks, and a few other marine invertebrates, are already in my cabinet, unidentified, which I have provisionally referred to the Pliocene.

For lack of material this period is rather hastily dismissed for an older epoch, or rather to consider an older series of fossils from this prolific region—a series originally described by Conrad as Miocene, by Gabb referred to the Pliocene, but evidently, according to my judgment, not more recent than the Miocene, and more likely to prove of Cretaceous age, as Conrad is credited with having suggested later in life.

THE CARRIZO CREEK OYSTER BEDS.

"Approaching Carrizo Creek, we saw, for the first time in many days, strata of unchanged sedimentary rock. These consist of shales and clays of a light brown or pinkish color, forming hills of considerable magnitude at the base of the mountains. From their soft and yielding texture they have been eroded into a great variety of fantastic and imitative forms. This series of beds have been greatly disturbed, in many places exhibiting lines of fracture and displacement. Where they are cut through in the bed of Carrizo Creek, they contain concretions and bands of dark brown ferruginous limestone, which include large numbers of fossils, ostreas and anomias. These have already been described by Mr. Conrad, and are considered of Miocene age. In the debris of these shale beds I found fragments of the great oyster (*Ostrea Titan*), characteristic of the Miocene beds of the Californian coast. A few miles

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north of this point, similar strata, probably of the same age, were noticed by Dr. Le Conte, but there they contain gnathodon, an estuary shell, showing that the portion of the desert where they are now found was once covered by brackish water."—*J. S. Newberry.*

In the spring of the present year (1890), I made a large collection of these fossil oysters in the neighborhood of Carrizo Creek, mainly to the south. A series of these was sent to the United States Geological Survey.

The following is the information elicited in return. This was signed with a rubber stamp by the "Chief Clerk:"

The oyster shells, coral, and sea urchins forwarded to this office for identification and referred to in your letter, have been examined by one of our experts, who reports:

"I have examined some oyster shells from the Colorado Desert, referred to in the accompanying papers and, also, the notes accompanying them. The species are probably Miocene; they are in very bad condition, so that it is difficult to speak confidently of their relations.

"The small oyster is *Ostrea subfalcata* Conrad. The oysters appear to be in a very bad state, and not identifiable with confidence. They are not distantly related to forms now living in the Gulf of California.

"The coral is waterworn and a pseudomorph in silica so that it presents no structure, and we can only say it belongs to the Ostræa family.

"The sea-urchins cannot be determined from the sketches, and very likely not from the specimens, as that group in our Tertiary has been but little studied, and there are many fossil species very little known. There is no one here who has studied them sufficiently to identify the species except those of our Atlantic Coast, and even these are in a very confused state."

Evidently the coral sent from the Colorado Desert had received no attention, as the above note seems to apply to another form from the Cretaceous beds along the coast of Baja California. The coral from the Carrizo Creek region is quite different in character.

All the specimens sent were numbered, to avoid confusion, as material from several localities were sent together. These numbers were wholly ignored, however, and the reports received leave me but slightly wiser than before. Other collections, sent from the Tertiaries of the Lower California coast in 1877, have not even yet been reported upon by the Survey.

I should like to learn what species of oysters exist in the Gulf of California that are not "distantly related" to these Carrizo Creek forms. They seem to me more nearly related to Cretaceous forms than to any living species with which I am acquainted.

More recent formations, evidently Pliocene in age, are found in the vicinity of these ancient oyster beds, and an acquaintance with these may have led Mr. Gabb to refer them all to that period.

The following is a list of the Tertiary *Ostreidæ* of California, so far as at present known to the writer:

OSTREA LURIDA Carpenter, Moll. W. N. Am. (S. I. Misc. Coll., 252), page 305; Heilprin, Fossil Ostreidæ of N. Am., 316, pl. 72, fig. 2, 3.—Pacific Coast, living and in the Pliocene beds.

OSTREA CONCHAPHILA Carpenter, Post-Pliocene.—"San Diego and False Bay, probably *O. lurida*."—*Heilprin*, l. c., 315. This species I consider a form only of the last.

OSTREA ATWOODI Gabb, Palæontology of Calif., II, 33–34, pl. x, fig. 58, 58*a*, and pl. xi, fig 58*b*; Heilprin, l. c., 312, pl. 48, fig. 4, 5.—"Miocene or Pliocene."

OSTREA VEATCHII Gabb, l. c., II, 34–60; Heilprin, l. c., 316, pl. 72, fig. 1.—Gabb places this in the Post-Pliocene. My specimens from Carrizo Creek seem closely related to, if not identical with, Lamarck's *Ostrea*

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bellovacina of the Eocene strata of Europe. This, or a nearly related form, has been described from the Eocene of Maryland as *O. compressirostra* Say.

OSTREA HEERMANNI Conrad, Proc. Phila. Acad. Sci. (1855), 267; Pac. R. R. Rept., V, 326.—Described from Carrizo Creek, and referred to the Miocene. Conrad is credited with saying later that this is "probably a Cretaceous species."—*Heilprin*, l. c., 314. Gabb (l. c., II, 107) refers it to the Pliocene.

OSTREA SUBFALCATA Conrad.—The oyster identified as this species by the United States Geological Survey greatly resembles the figures of *O. larva*, a Cretaceous species, credited with a wide distribution in Europe, India, New Jersey, and Alabama. Whether identical or not can only be determined by a careful comparison of a large series of authentic specimens.

OSTREA VESPERTINA Conrad, Jour. Phil. Acad. Nat. Sci. (n. s.), II, 300; Mex. Bound., I, 160; Pac. R. R. Rept., V, 325; Heilprin, l. c., 315; Gabb, l. c.—Conrad described this from Carrizo Creek, and referred it to the Miocene. Gabb considered it Pliocene, but was undoubtedly in error. Cooper credits it to the Pliocene of Santa Barbara, San Fernando, Los Angeles County, and to the Colorado Desert. It has also been credited to the vicinity of San Diego; but only the original locality where the types were collected (Carrizo Creek) can be considered authentic. Cooper in referring it to the Pliocene simply followed Gabb in compiling his list of California fossils. I should rather refer it to the Cretaceous than to a more recent period than the Miocene.

OSTREA TITAN Conrad, Pro. Phil. Acad. Nat. Sci., VI, 199; Jour. of same (n. s.), IV, 300; Pac. R. R. Rept., VI, 72; Heilprin, l. c., 313.—Characteristic of the Miocene of the California coast. Carrizo Creek. "Throughout Upper Miocene of the Coast Ranges to Lower California."—*Cooper.*

OSTREA TAYLORIANA Gabb, l. c., II, 34; Heilprin, l. c., 313.—Miocene.

OSTREA PANZANA Conrad, Pac. R. R. Rept., VII, 193; Heilprin, l. c., 313.—Miocene. "Perhaps mature *O. subjecta*."—*Conrad.*

OSTREA SUBJECTA Conrad, l. c., 193; Heilprin, l. c., 313.—Miocene.

OSTREA VELERIANA Conrad, Mex. Bound., I, pt. II, 160; Heilprin, l. c., 314.—Miocene (?) of Arizona. Colorado Desert (?).

OSTREA GALLUS Valenciednnes, Voyage de la Venus Atlas de Zoölogie, pl. 21.—A recent species figured without description, *O. cerrosensis* Gabb (l. c., 35, 106), from Cerros Island, is considered identical. Heilprin, l. c., 315. I have this from the Pliocene of San Quintin Bay, Baja California.

ANOMIA SUBCOSTATA Conrad.—Miocene. Carrizo Creek.

PECTEN DESERTI Conrad.—Miocene. Carrizo Creek.

BALANUS ——— ?—Miocene. Carrizo Creek.

Various gasteropods and an echinoderm are in my collection from this same region, together with a coral, a few fossil plants, etc. Until more material has been secured and carefully studied, it is thought best to postpone further remarks on these interesting remains.

In the shale near Coyote Wells, I secured the impressions of the leaves of evidently some species of aquatic plant with floating leaves, resembling in shape somewhat that of the genus *Brasenia*, as L. F. Ward suggests.

The Carboniferous period seems to be represented also among the fossils from this region. W. P. Blake has also reported fossils of this age

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MINES AND MINING—QUICKSILVER.

The following most exhaustive article on the production of quicksilver is from "Census Bulletin," No. 10, issued at Washington, D. C., August 22, 1890:

DEPARTMENT OF THE INTERIOR, CENSUS OFFICE,
WASHINGTON, D. C., August 1, 1890.

Recognizing the value of prompt publication of statistics, the following bulletin is issued, showing the statistics of quicksilver at the Eleventh Census, as prepared by Hon. J. B. Randol, special agent in charge of that subject, under the supervision of Dr. David T. Day, of the United States Geological Survey, and special census agent in charge of mines and mining. The bulletin also shows the value of the quicksilver, the wages and other expenses, and the capital required for this product. This statement is only a brief summary of the more important facts which will be published in the complete report.

No similar statement concerning quicksilver was published at the Tenth Census, therefore, comparisons cannot be made. A table is given, however, showing the total product of quicksilver of the world, and also the product of the United States in each year since the industry was first established.

ROBERT P. PORTER,
Superintendent of Census.

QUICKSILVER MINES AND REDUCTION WORKS.

By J. B. RANDOL.

During the calendar year 1889 there were twenty-six thousand four hundred and sixty-four flasks, or two million twenty-four thousand four hundred and ninety-six pounds, or one thousand and twelve short tons of quicksilver produced in California. About twenty flasks, less than $1,000 in value, were produced in Oregon. The product is notably less than the usual yield. In 1888, thirty-three thousand two hundred and fifty flasks were produced.

ESTABLISHMENTS.

In the following table, under the heading of productive mines and turnaces, is included every establishment in the United States where cinnabar ore is known to have been mined and quicksilver produced therefrom, to the amount of $1,000 or more, during the period under review. The unproductive mines and furnaces include establishments, the stoppage of which was caused, among other reasons, by litigation, by low prices for quicksilver, and the consequent unprofitable results for the time being, or by lack of sufficient capital and experience to pursue

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0.286 per cent, and the average percentage yield in quicksilver for all the ore roasted was 1.088. The largest quantities of ore produced and roasted were, respectively, twenty-eight thousand and seven and twenty-eight thousand eight hundred and eighty-seven tons, and the quantity of quicksilver produced at the several works ranged from one hundred and twenty up to thirteen thousand one hundred flasks. The following table exhibits the quantity of ore produced and roasted in 1889, the number of flasks of quicksilver produced, and the percentage of yield:

YIELD OF QUICKSILVER FROM ORES ROASTED IN 1889.

Number of Establishments.	Ore Produced—Short Tons.	Ore Roasted—Short Tons.	Quicksilver Produced—Flasks.	Yield—Per Cent.
1	7,168	7,168	1,874	1.000
1	9,880	9,880	2,283	0.884
1	7,440	7,440	556	0.286
1	200	200	120	2.295
1	4,742	3,992	812	0.778
1	23,500	23,500	4,590	0.746
1	3,400	3,400	804	0.905
1	3,877	3,377	980	1.110
1	28,007	28,887	13,100	1.734
1	7,000	6,120	1,345	1.000
1	1,000			
11	95,714	92,964	*26,464	1.088

EXPENDITURES.

The following table shows the value of supplies of all kinds consumed during the year 1889; "the aggregate of all wages paid;" total of all other expenditures for mines and works, including rent, taxes, etc.; number of flasks of quicksilver produced, and average cost per flask:

EXPENDITURES IN THE PRODUCTION OF QUICKSILVER IN 1889.

Number of Establishments.	Value of all Supplies.	Aggregate of all Wages.	Total of all other Expenditures.	Number of Flasks Quicksilver Produced.	Average Cost per Flask.
1	$53,567 00	$104,608 00	$760 00	4,590	$34 63
1	5,975 00	8,060 00			(‡)
1	†4,000 00	20,936 00	750 00	804	31 95
1	4,000 00	12,591 00	1,000 00	812	21 66
1	9,564 00	43,241 00	1,042 00	1,874	28 73
1	21,973 00	47,208 00	2,507 00	2,283	31 40
1	9,034 00	25,352 00	2,167 00	556	65 74
1	1,500 00	2,250 00		120	31 25
1	3,114 00	27,546 00	79 00	980	31 36
1	86,428 00	304,341 00	26,826 00	13,100	31 87
1	20,467 00	30,156 00	359 00	1,345	37 90
11	$219,622 00	$626,289 00	$35,490 00	26,464	$33 31

From the above table it will be seen that at eleven active establishments there were expended $219,622 for supplies, $626,289 for wages,

* One mine in Oregon produced twenty flasks, the total product in that State. They are not included, being less than $1,000 in value.
† Estimated; correct amount unobtainable.
‡ Ore mined, but none roasted, and therefore omitted in average cost per flask.

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year. For foremen at underground work the average wages ranged from \$4 68 to \$2 75 daily. Miners earned an average of \$2 67 to \$1 25, the lowest rate being for Chinamen, of whom a few were employed at small establishments:

WAGES OF FOREMEN AND MINERS UNDERGROUND.

Number of Establishments.	Foremen.			Miners.		
	Average Number Employed Daily.	Average Wages per Day.	Average Number of Days' Work for Year.	Average Number Employed Daily.	Average Wages per Day.	Average Number of Days' Work for Year.
1	1	\$2 90	340	*6	\$2 40	300
1	1	4 00	360	20	2 67	360
1				22	2 45	263
1	1	2 75	110	†5	1 22	40
1	2	4 68	306	‡233	2 66	279
1	3	3 06	340	†80	1 25	340
1	1	4 50	316	6	2 05	284
1				6	1 50	336
8	9	§\$4 68 ¶2 75	§360 ¶110	378	§\$2 67 ¶1 22	§360 ¶40

WAGES OF LABORERS UNDERGROUND.

Number of Establishments.	Laborers.		
	Average Number Employed Daily.	Average Wages per Day.	Average Number of Days' Work for Year.
1	‖24	\$1 90	290
1	5	2 17	360
1	1	2 00	300
1	19	2 09	267
1	‖25	1 50	340
1	3	1 65	315
1	4	1 35	336
7	81	§\$2 17 ¶1 35	§360 ¶267

* Miners embrace timbermen and machine drill men.
† Chinese.
‡ Miners comprise tributers, \$2 41; drillers per foot on contract, \$2 33; drifting on contract, \$2 80; timbermen, \$3; blasters, \$2 75 per day.
§ Highest.
¶ Lowest.
‖ Laborers embrace helpers and hand drillers at \$1 90 per day.

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TOTAL NUMBER OF EMPLOYÉS UNDERGROUND.

Foremen.	Miners.	Laborers.
9	378	81
--	----	*53 unclassified.
9	378	134

The following table gives the number of office force, total pay of same, total wages of all other employés, and the aggregate wages paid to all employés:

TOTAL WAGES.

Number of Establishments.	Number Employed.	Total Pay.	All Other Wages.	Total Wages.
1			$25,352 00	$25,352 00
1			2,250 00	2,250 00
1			20,936 00	20,936 00
1	1	$800 00	29,356 00	30,156 00
1	3	2,520 00	†40,721 00	43,241 00
1	2	3,900 00	23,646 00	27,546 00
1	2	3,366 00	43,842 00	47,208 00
1	7	17,560 00	‡286,781 00	304,341 00
1	**3	5,200 00	99,408 00	104,608 00
1	1	1,200 00	§11,391 00	12,591 00
1	1	420 00	7,640 00	8,060 00
11	20	$34,966 00	$591,323 00	$626,289 00

During the census decade, 1880–1889, there were no strikes or labor troubles of any kind in any of the mines and works, and fair wages for good work was the rule for employers and employés.

POWER.

The active establishments employed sixty-two steam motors, with a capacity of two thousand one hundred and ninety horse-power, fifty-four boilers of two thousand four hundred and thirty-eight horse-power, one electric dynamo and motor of four horse-power, and one waterwheel of three horse-power—a total of two thousand one hundred and ninety-seven horse-power in motors. Two hundred and forty-seven animals were also reported as employed, but it is probable a greater number were in use. The details for the respective establishments are shown in the following table:

* Of which 32 were reported as Chinese, without classification, 362 days, at $1 17 per day.
** Only one woman employed in all the establishments.
† $300 paid to contractors included.
‡ $10,606 paid to contractors included.
§ $375 paid to contractors included.

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POWER USED IN QUICKSILVER MINING AND REDUCTION.

Number of Establishments.	Steam Motors.		Boilers.		Other Motors.		Number of Animals.
	Number.	Horse-power.	Number.	Horse-power.	Number.	Horse-power.	
1	2	50	2	30			4
1	5	230	5	140			4
1	3	90	2	125			4
1	2	150	5	155			12
1	2	50	4	100			12
1	7	185	5	400			15
1	29	1,000	23	1,088	2	*7	114
1	5	170	3	200			52
1	7	265	5	200			20
1							10
10	62	2,190	54	2,438	2	7	247

VALUATION OF MINES AND WORKS.

The following statement gives an estimated valuation of the active mines and works as nearly as the same could be ascertained:

VALUE OF QUICKSILVER ESTABLISHMENTS.

Number of Establishments.	Mines and Other Real Estate	Furnaces, Houses, and Other Surface Improvements	Machinery, Supplies, Tools, and Live Stock	Quicksilver Unsold	Bills and Accounts Receivable	Other Assets	Estimated Total Capital
1	$276,530	$50,000	$58,850	$96,660		$108,513	$590,553
1	30,000	13,300	2,000	4,700			50,000
1	65,000	25,000	10,000	6,460		2,000	108,460
1	6,940	14,000	3,300	95			24,335
1	20,000	5,000	5,000	2,500			32,500
1	100,000	25,000	30,000				155,000
1	12,000	5,000	10,000				27,000
1	20,000	10,000	5,000	859	$9,664	4,943	50,466
1	50,000	25,000	10,000	2,900	25,000	10,000	122,900
1	25,000	15,000	10,000	9,900			59,900
†6	75,000	35,000	2,000				112,000
16	$680,470	$222,300	$146,150	$124,074	$34,664	$125,456	$1,331,114

Some mine owners placed a higher valuation on their mines and improvements than is given in the foregoing statement; but it is preferred to take what may be considered a conservative opinion of the values as of December 31, 1889. Undoubtedly the original investments in the properties were many times the amounts of present estimates, but it must be remembered that mines are generally decreased in value by the extraction of ore for a long period of continuous work, which has been the case with the quicksilver establishments of the United States.

* One waterwheel of three horse-power, and one dynamo and motor of four horse-power.
† Non-productive.

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STATISTICS FOR EARLIER PERIODS.

The earliest records relating to production of quicksilver in California are for 1850, cinnabar having been first discovered there in 1845, and but very little quicksilver was produced prior to 1850, when active work was commenced at New Almaden. Outside of California, quicksilver has been produced in two localities in the United States: in Oregon, to the extent of two thousand flasks, and in Utah, where about two hundred flasks were reported.

In closing this brief report two tables are submitted. The first gives the production of quicksilver at the principal mines of the world for the last ten years. The last gives, in periods of ten years, the production in California, the average yearly price per flask in San Francisco, and a valuation, at the average sale price, for each census decade:

THE WORLD'S PRODUCTION OF QUICKSILVER FOR TEN YEARS.

YEAR.	Total of all Mines, United States—Flasks.	Almaden Mine, Spain—Flasks.	Idria Mine, Austria—Flasks.	Italian Mines—Flasks.	Total Foreign Mines—Flasks.	Grand Total, Yearly—Flasks.
1880	59,926	45,322	10,510	3,410	59,242	119,168
1881	60,851	44,989	11,333	3,760	60,082	120,933
1882	52,732	46,716	11,663	4,110	62,489	115,221
1883	46,725	49,177	13,152	6,065	68,394	115,119
1884	31,913	48,098	13,967	7,850	69,915	101,828
1885	32,073	45,813	13,503	6,965	66,281	98,354
1886	29,981	51,199	14,496	7,375	73,070	103,051
1887	33,760	53,276	14,676	7,075	75,027	108,787
1888	33,250	51,872	14,962	9,830	76,664	109,914
1889	26,464	49,477	15,295	10,000	74,772	101,236
Totals	407,675	485,939	133,557	66,440	685,936	1,093,611

RECAPITULATION.

	Flasks.
Almaden Mine, Spain	485,939
Idria Mine, Austria	133,557
Italian Mines	66,440
Total	685,936
Total of all mines in the United States*	407,675
Foreign mines, excess	278,261

*All from California mines. About two thousand flasks from Oregon, and two hundred flasks from Utah are not included in the above, as no yearly details were obtainable.

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Quicksilver Product in the United States.

Year.	Yield in California—Flasks.	Average Price for Decade.	Approximate Valuation.
1850	7,723	$99 45	$768,000 00
1851	27,779	66 92	1,859,000 00
1852	20,000	58 32	1,166,500 00
1853	22,284	55 45	1,235,500 00
1854	30,004	55 45	1,665,500 00
1855	33,000	53 55	1,768,000 00
1856	30,000	51 65	1,549,500 00
1857	28,204	49 72	1,402,000 00
1858	31,000	47 82	1,482,500 00
1859	13,000	63 12	820,500 00
	242,994	$56 45	$13,717,000 00
1860	10,000	$53 55	$535,500 00
1861	35,000	42 10	1,473,500 00
1862	42,000	36 35	1,526,500 00
1863	40,531	42 07	1,705,000 00
1864	47,489	45 90	1,761,500 00
1865	53,000	45 90	2,433,000 00
1866	46,550	51 62	2,403,000 00
1867	47,000	45 90	2,157,000 00
1868	47,728	45 90	2,191,000 00
1869	33,811	45 90	1,552,000 00
	403,109	$44 00	$17,738,000 00
1870	30,077	$57 37	$1,725,500 00
1871	31,686	63 10	1,999,500 00
1872	31,621	65 97	2,086,000 00
1873	27,642	80 32	2,226,500 00
1874	27,756	105 17	2,919,000 00
1875	50,250	84 15	2,721,000 00
1876	75,074	44 00	3,303,000 00
1877	79,396	38 30	3,041,000 00
1878	63,880	32 90	2,101,500 00
1879	73,684	29 85	2,199,500 00
	491,066	$49 53	$24,322,500 00
1880	59,926	$31 00	$1,860,000 00
1881	60,851	29 80	1,810,000 00
1882	52,732	28 25	1,500,000 00
1883	46,725	27 25	1,275,000 00
1884	31,913	30 50	975,000 00
1885	32,073	30 25	1,060,000 00
1886	29,981	35 50	970,000 00
1887	33,760	42 25	1,425,000 00
1888	33,250	42 50	1,415,000 00
1889	26,464	45 00	1,190,500 00
	407,675	$33 07	$13,480,500 00

Recapitulation.

Decade.	Flasks.	Value.
1850–59	242,994	$13,717,000 00
1860–69	403,109	17,738,000 00
1870–79	491,066	24,322,500 00
1880–89	407,675	13,480,500 00
Totals	**1,544,844**	**$69,258,000 00**

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MINERAL LANDS WITHIN THE RAILROAD GRANT. EAGLE BIRD MINE, NEVADA COUNTY.

The case of George H. Francoeur vs. Oscar Newhouse, in the United States Circuit Court, Ninth Circuit, Northern District of California, has attracted considerable attention because of the novelty of the point raised by the plaintiff, as grantee of the Central Pacific Railroad Company, as also by reason of the great value of the property in controversy (which was over $1,000,000), and the importance of the principles established therein, which affect the title to all mineral lands on the odd sections of land lying within the grant of the United States Government to the railroad, to aid in the construction of a railroad from the Missouri River to the Pacific Ocean.

The case was on trial three weeks, the plaintiff being represented by ex-Attorney-General A. L. Hart, and the plaintiff *in propria persona*, assisted by Wm. Singer, attorney for the Land Department of the C. P. R. R. Co.; the defendant being represented by Reinstein & Eisner and James M. Seawell.

The verdict was in favor of the defendant on all the issues.

In the Circuit Court of the United States, in and for the Ninth Circuit, Northern District of California.

The Hon. Lorenzo Sawyer, Judge.

George H. Francoeur vs. Oscar Newhouse.

Wednesday, August 6, 1890.

The following is the charge of the Court to the jury:

CHARGE TO THE JURY.

The Court (orally): Gentlemen of the jury, I announce to you that I have prepared some special issues in addition to the general verdict, upon which I desire you to find. It may save future litigation. I will read them to you so that you will be prepared to appreciate what I have to say upon these points. The first is: "We, the jury in the above entitled case, find for the plaintiff or defendant," whichever it turns out to be. You will write in either "plaintiff" or "defendant," according as you find on all the issues in the case.

The next one is: *First*—Was the land in question known to be mineral, or was there good reason to believe it was mineral, at the date of filing the map of general location of the route of the road, and the withdrawal of the lands by order of the Secretary of the Interior on August 2, 1862?

Second—Was the land in question known to be mineral, or was there good reason to believe that it was mineral, at the time that the line of the road was definitely located in 1866?

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Third—Is the land in question, in fact, mineral land?

Fourth—Had the defendant and his grantors been in continuous, open, and notorious adverse possession of the premises in question, claiming to be in the rightful possession under the laws, and afterwards under a patent of the United States, adverse to the claim of the plaintiff and his grantor, for a period of five years next before the commencement of this suit, on June 28, 1889?

Gentlemen, I will now proceed to state to you the law which governs this case, which is the province of the Court to determine. You will take it, and apply it as given to you by the Court, whether it meets with your approbation or not. It will then be your province to find the disputed facts in the case, and those issues you are to find, upon the testimony before you, either for the plaintiff or for the defendant, as the preponderance of proof in your judgment requires. It only requires a preponderance of proof.

You are the exclusive judges of the testimony, and to you alone belongs the finding of the facts. You are to examine the testimony of each witness. You are the judges of the credibility of the witnesses. You are to consider the intrinsic character of the testimony, whether it is intrinsically probable or not. You will consider any circumstances which affect the credibility of the witnesses, and give the testimony of each witness such weight as you think it is entitled to receive, and render your verdict as the preponderance of the evidence appears to be in your minds.

The deed to the plaintiff from the Central Pacific Railroad Company is dated February 13, 1889, only two or three months before the commencement of the suit. The deed, it is true, is quit-claim deed, but if the title to the premises in question was in the Central Pacific Railroad Company at that time, that deed conveyed the title to Francoeur, and in that case if the title was in the Central Pacific Railroad Company and conveyed to Francoeur, there must be a verdict for the plaintiff on that issue, and the plaintiff will be entitled to recover, unless the other defense of the bar by the Statute of Limitations, is found in favor of the defendant, in which case, of course, that will control.

The first great question to determine is: Was the title in the Central Pacific Railroad Company at the date of that deed? If it was, it must have passed under the Act of 1862, granting lands in the aid of the construction of the Central Pacific Railroad Company, and if the title vested under that Act, then the United States had nothing left in it, and it could afterwards convey no title by patent to the defendant in this case.

The Act of 1862 granted all sections with odd numbers within a space of ten miles on each side of the road to the Central Pacific Railroad Company, to which some other right had not attached at the date of the final definite location of the road, and mineral lands were excepted. If the land in question was mineral land within the meaning of that Act, the title never passed to the Central Pacific Railroad, because it was not granted—it was excepted out of the grant. If it was not mineral land, and there is no claim that any of the other rights had attached, then of course the title passed to the Central Pacific Railroad Company; so it is important to inquire whether, at the time the right of the company specifically attached to this land, it was mineral land within the meaning of this provision of the statute. That is a question for you to determine. If you determine that it was mineral land, that ends the case,

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because the company had no title which it could convey to the plaintiff in this case; and he relies upon no other title.

The complaint alleges and shows, and all of the testimony shows, and there is none to the contrary, that these premises are *in fact* mineral land. They were worked for years, and a large quantity of gold taken out of them. They are in fact, now, and were at the commencement of this suit, according to their own allegations, mineral lands. If they were, in fact, mineral lands at the time of the commencement of this suit, they must necessarily have been in fact mineral lands in 1862, at the date of the passage of this Act, and such lands as Congress designed to exclude or except from the operation of the grant, for the character of the lands in this particular has not changed; but it has been held by the Courts that only those are to be regarded as mineral lands within the meaning of the Act of Congress, which were known to be mineral, or which there was satisfactory reason to believe were mineral at the time of the attaching of the right of the company to those particular lands.

As it has been stated in the language of the Courts, the words "mineral land," as used in the Act of Congress, mean land known to be mineral at the time the grant took effect, and attached to the specific land in question, or which there was satisfactory reason to believe were such at said time. Only such land as was known to be mineral, or which there was satisfactory reason to believe was mineral, at the time the grant attached to the land, is excepted from the grant.

Gentlemen, you have the starting point that these premises were, in fact, mineral lands at that time. The question then arises: Whether or not they were known or there was sufficient reason to believe, at the time this grant attached—and that is when the line of the road became definitely fixed, according to my construction of the Act—to be mineral land, or whether there was sufficient reason to believe they were mineral lands? Perhaps that is a little too restricted, because there may be mineral land on portions of land so apparent and obvious that any one seeing it, would know it on sight, and yet no one may have been at that point to observe it at the time; yet because no one happened to be there, if the fact of it being mineral land is so obvious that it would have been manifest to any one who inspected it, that I take to be mineral land within the meaning of this Act. But it is sufficient for this case to take the other definition. For the purpose of this case, these lands were, in fact, mineral. The question is: Were they known to be mineral within the meaning of the Act, or was there good reason to believe they were mineral?

Gentlemen, you heard the testimony on that point. There is testimony here tending to show that persons did visit them, saw this mine, and saw men at work on this very ledge as early as 1862, and earlier. That is a long time ago. Of course you cannot expect to find very definite and precise testimony in regard to transactions that occurred so long ago, but you take that in connection with the fact that they were mineral, and take such other testimony as was presented to you, and give it such weight as you think it entitled to, for the purpose of determining whether it was known to be mineral, or there was good reason to believe at the time that it was mineral. All the testimony shows the land was good for nothing for agricultural purposes, and there was very little timber on this piece of land according to the testimony; so if it was good for anything, it was, perhaps, good for mining purposes. You

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of the map of definite location or, when no such map is filed, from the time of the definite location in fact of the road. The map of general location was filed in 1862, but no map of definite location was filed until the completion of the road, so far as the evidence discloses. On the contrary, the allegations in the complaint are that the road was definitely located in 1866. There is no allegation that it was located earlier, and the presumption is that they allege it at the earliest day justified by the facts, and the jury are entitled to consider that that is the time when the road was definitely located, there being no allegation or averment that it was located on an earlier day, or you might say the day before. Until that definite location, it could not be determined where the grant would fall, and to what land it would attach. When the definite location is filed, they cannot change it afterwards. Between the filing of the map of definite route and the general location, there was a right to vary the line, because instead of being ten miles on each side of the road, there were fifteen miles withdrawn within which to swing—five miles on each side—to vary the line of the road and still maintain their rights. At this time, in 1866, was the land in question known mineral land, or was there good reason to believe it to be mineral land? Take all the testimony in the case, and find on that issue as you think the preponderance of testimony is. There is considerably more testimony with reference to that than there was in regard to the prior date, 1862.

Is the land in question *in fact* mineral land? Upon that issue there is no conflict of testimony. It is alleged in the complaint itself that a gold mine was discovered as early as 1883, and the parties took it up and took possession of it. The testimony all shows that it was worked for years and large quantities of gold taken out, so that there is no conflicting testimony in regard to that question. If you find that this was known mineral land within the meaning of the Act, or land that there was good reason to suppose to be mineral land at the time the grant attached, then it is within the exception of the grant, and you must find for the defendant. If you find that it was not known mineral land, and there was no good reason to believe it was mineral land, at the date, 1862, you will find for the plaintiff on that issue. As to the second date, 1866, the same rule will apply. If you find it was known mineral land in 1866, the date when the road became definitely located, or there was good reason to believe it was mineral land, you will find for the defendant.

On the contrary, if you find it was not mineral land at that date, or there was not then good reason to believe it was, you will find for the plaintiff on that issue.

If you find for the plaintiff on those two issues, the title would be in favor of the plaintiff, and you would have to find a verdict in favor of the plaintiff unless the defendant establishes the defense of the statute of limitations.

The defendant has set up the statute of limitations.

The law of California is, that if a person has been in the actual, notorious, adverse possession of land for a period of five years, the right of action of the real owner is barred, and the title as to him becomes effectually vested in the defendants.

There is testimony tending to show that they worked continuously on that claim, expended a large amount of money—away up towards the hundred thousands—in improvements in and about the mine, and

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the United States, either with or without a claim on his part of the right to acquire the title to the United States, and it is sufficient if he has such possession as is required by the statute, and claims in hostility to the title which the plaintiff establishes in the action."—*Id.* And this doctrine was repeated in 48 Cal. 15.

These parties not only admitted the title of the United States, but claimed the right to enter under their laws, and they claimed a patent under those laws, and got it. They claim in hostility, so far as the evidence shows, to the title of this complainant. The testimony tends to show that their possession commenced as early as 1882 or 1883, at the latest. The testimony also tends to show that the possession was continuous under these claims to a part, with a claim to the whole, according to the boundaries of their deed, down to the commencement of this suit.

If you find that to be a fact, the bar of the statute attaches, and you must find a general verdict for the defendant, and a verdict for defendant under this last special issue submitted to you. If you find they did not, and were not in continuous possession adverse to this plaintiff during that time, and it was broken, they have failed to maintain the bar of the statute of limitations.

Gentlemen, this is all I think it necessary to say to you upon the subject. I hand to you the issues. The first one you will find for the plaintiff or defendant, as you find the case to be. If you find for the plaintiff, you must find on all the issues against the defendant, except the third. If you find on one, except the third, against the plaintiff, you must find a general verdict for the defendant. As to the others, you will answer yes or no, according as you find them to be.

I will name Mr. Dutton foreman of the jury.

Mr. Hart: If your Honor please, we desire to take an exception to that portion of the charge which directs the jury that circumstances which would give a reasonable belief that this land was mineral in 1866, would authorize them to find that it was known mineral; and also to the same part of the charge with reference to the map of 1862; and also to that portion of the charge which directs the jury that the rights of the railroad company attached in 1866, and not at the date of the passage of the Act. We also except to that portion of the charge which directs the jury that entry upon lands under a conveyance claimed adversely—that is, upon a portion of the land—to the railroad company, but not adversely to the Government of the United States, would be sufficient to put the defendant in the constructive possession of the whole. We also except to that portion of the charge which instructs the jury that it is not necessary for a party to enter under a deed claiming title to the property exclusive of other rights. We also except to that portion of the charge which directs the attention of the jury to the exception or the reservation contained in the deed of the railroad company to Francoeur, and also to that portion of the charge which contains the rehearsal of the evidence, and states to the jury what that evidence tends to prove.

The Court: Note the exception. The jury understands the whole decision on the facts is left to them. I merely point out the tendency of the evidence.

A Juror: I would like to know if the terms "adverse" and "notorious" are synonymous?

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GOLD EXTRACTION BY POTASSIUM CYANIDE.

By WM. D. JOHNSTON, M.D., Chemist State Mining Bureau.

The "Macarthur-Forrest" process for the treatment of refractory gold ores is thus described by William Jones in the "Engineering and Mining Journal" (December 21, 1889):

This process depends upon the great chemical affinity of cyanogen for gold and silver, and the ease with which these metals form soluble double cyanides with the alkali metals. Of the common metals, gold has the greatest affinity for cyanogen, and their relative affinities are as follows: First, gold; second, silver; third, copper; fourth, zinc—lead, iron, arsenic, antimony, etc., very small.

I do not propose to discuss in this paper the chemical forms in which gold exists in these so called gold ores; suffice it to say that so great is the affinity of gold for cyanogen that I have yet failed to meet with any ore which did not, on shaking up with even dilute solutions of cyanides, yield up its contents of gold almost entirely to the cyanide solution, and become dissolved as the double cyanide of gold and the alkali used.

The cyanides of the alkali and earthy metals are, practically speaking, the only soluble cyanides; the cheapest and the most common being the cyanides of potassium and sodium.

The relative solvent action of these various cyanides on gold and silver compounds, and on the gold and silver compounds existing in ores, has been most carefully and thoroughly investigated by Mr. J. S. Macarthur and Dr. Forrest, who have had a staff of research chemists at work on the subject for nearly three years. It has been found that the cyanides of potassium and sodium are as active in their solvent action as any of the other soluble cyanides.

When ores containing gold, silver, copper, zinc, etc., are treated with solutions of cyanide of potassium or sodium, they are dissolved more or less, forming soluble double cyanides. The solvent action of the base metals can be reduced to a minimum by reducing the strength of the solutions, the readily soluble gold and silver being easily dissolved out with only traces of copper, zinc, etc. The action of these weak cyanide solutions on the metals iron, lead, arsenic, antimony, etc., is practically nil, and the solvent action on copper or zinc much depends upon the state of chemical combination in which they exist.

Thus the hydrated oxides and carbonates of copper are more soluble than the sulphides, and the oxide of zinc more soluble than the sulphide of zinc; again, the white sulphide of iron is more soluble than the yellow sulphide.

The best strengths of solutions to use in "leaching" out the gold from these so called refractory ores depends entirely upon the nature of the ore, and it is impossible to set any hard and fast line. The strength of solutions generally used vary from one eighth to one per cent of cyanide of potassium. The correct strength to use in treating any class or lot may be readily determined by treating a weighed quantity of the ore with varying strengths of cyanide solutions for various periods of time in the laboratory, and analyzing the ore after treatment with the cyanide liquor, and the liquor itself as to the amount of gold which they contain and the unconsumed cyanide in the liquor, these results being compared with the original contents of gold and silver in the ores, and the original strength in cyanogen of the solution used. (A neat and rapid method of determining the gold in the cyanide liquors is to draw off a known value and evaporate it to dryness over a beaker of water in a capsule shaped out of a piece of silver-free lead foil. The lead foil capsule is then wrapped up in a ball and cupeled in the usual way. The liquor should be as free as possible from base metals. When these are present, the liquor may be boiled to dryness with litharge, and the solid residue fused in the usual way for its contents of gold and silver.)

The approximate strength of the solution to use is thus determined, the point aimed at being to reduce the quantity of cyanide actually consumed to a minimum, with, at the same time, the highest possible percentage of extraction of the gold and silver.

The process on a large scale is carried out as follows:

The ores (without any previous roasting of the sulphurets), ground to forty-mesh, are placed in pans or wooden vats provided with a stirrer, and to every one ton of the ore there is added about one hundred gallons of water containing one quarter, one half, or three quarters of one per cent of cyanide of potassium or sodium, or other percentage which experiment in the laboratory shows to be the best approximate strength to use. The whole is then stirred for four to eight hours, the length of time depending upon the nature of the ore. Some ores give better results by grinding in the pan. Others require merely agitation with the liquor.

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The liquor is run off, carrying with it on an average 85 per cent of the gold contents of the ore, and 80 per cent of the silver. It is filtered, and the gold and silver in it are precipitated by passing slowly through zinc turnings, when complete precipitation of the gold and silver takes place; they attach themselves as a loose powder to the zinc, and are easily removed by shaking or stirring, the gold and silver precipitate or "sludge" falling to the bottom of the vessel, and is removed, dried, and melted in the usual way.

The filtration of the liquor is accelerated by using a vacuum, and there is no practical difficulty about this part of the process, except in the case of ores containing a large percentage of clayey matters.

Concentrates work admirably, settling and filtering with the greatest facility.

The action of the cyanide of potassium or sodium upon the metallic zinc is very trifling; exact experiments with accurately weighed quantities of zinc subjected to the action of hundreds of gallons of liquor having proved this, and the complete precipitation of the gold, etc., having also been carefully investigated. The precipitation by zinc is superior to electrical and other methods, and hence is adopted on the large scale.

The amount of free cyanide existing in the liquors after passing through the zinc is then determined by means of a standard solution of nitrate of silver, and the liquor is again made up to its original strength and again used.

The actual consumption of cyanide on the large scale per ton of ore necessarily varies, running from one and one half pounds to eight pounds per ton. I am, however, of the opinion it will average about five pounds of cyanide of potash or soda per ton. At the same time, I have witnessed ores successfully treated with a consumption of only one and three fourths pounds of cyanide per ton—notably a very refractory South African pyrites containing over three ounces of gold per ton, the gold extraction being over 90 per cent.

In order to successfully carry out the extraction of the gold from these so called refractory ores, a number of points have to be observed. If the ores contain a noted acidity, due to the presence of basic sulphates of iron, etc. (especially marked in the case of disintegrated and weathered sulphides of metals), it should be neutralized with the equivalent quantity of caustic lime, in the form of milk of lime. The exact amount of acidity can be readily determined by shaking up a weighed sample of the ore with water, and adding standard normal or tenth normal caustic soda solution till the point of alkalinity is attained, as determined by litmus or other indicator. The amount of lime required is then easily calculated. Some ores show as much as 4 per cent of acidity, in terms of soda, and such ores on treatment with cyanide solutions without previous treatment with lime, show no extraction of their gold contents; whereas, when previously treated with lime, the greater part of the gold was easily extracted. Nearly all sulphides show more or less acidity, but when it is under one tenth of 1 per cent it may, for practical purposes, be neglected.

The cyanide solution used should be as free from caustic alkali ($NaHO$ or KHO) as possible, as it is apt to form a sulphide of sodium or potassium with the sulphur of the ores, and thus prevent gold and silver going into solution. This difficulty, when it does occur, is got over by adding chloride of calcium.

The cyanide solutions are best preserved from too great exposure to the air, as a part of the cyanide is apt to be converted by oxidation into the cyanate, an extremely stable compound.

This process is admirably suited for treating iron pyrites containing gold, as no roasting is required, and to ores containing fine or "float," which yield up their gold so easily that they can be treated by merely percolating the cyanide liquor through them. Complex ores containing antimony, arsenic, etc., also yield up their contents with great facility. I have had a large number of American and Mexican ores tested by this process, and the average extraction of the gold was 90 per cent and 85 per cent of the silver, the percentage of silver extracted being generally less than the gold. Works on this process are now running in New Zealand and Australia, and a plant is about to be erected at the Cape. The process owes much of its success to the skill and untiring efforts of Mr. J. S. Macarthur and Dr. Forrest, and is now the property of a strong company who have secured patents in all countries of the world.

The cyanide used on the commercial scale is cyanide, or mixture of cyanides of potash and soda, made by fusing the yellow ferro-cyanide of potassium with a pure soda ash and carbon in an iron pot, at a dull red heat, till the ferro-cyanide is decomposed, as ascertained by testing a small sample with an iron salt. The liquid mass is then ladled or run into iron molds to cool, and the cooled mass forms a black brick containing 75 per cent of cyanide of potassium or sodium. These bricks are made of a weight of about sixteen pounds each. They are packed in long zinc cases, soldered up, and shipped in wooden boxes to the mines or works.

The actual cost of manufacturing such a cyanide is not greater than 35 cents per pound. The above method is the old and well-known reaction.

Experiments are now in progress for utilizing the reaction (proposed as early as 1845) of passing nitrogen or furnace gases (free from oxygen) over highly heated alkali and carbon, barium being preferred. From my own experience of this process on a large scale, I hope to see the cost of the cyanide reduced to at least 20 cents per pound at an early date. I look for an early introduction of this process on a large scale into the United States.

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The claims set forth in the above article undoubtedly caused great surprise to the chemists as well as to the mining engineers of the civilized world. That cyanide of potassium would dissolve metallic gold and silver, forming soluble double cyanides of gold and silver, had long been known to chemists and electroplaters, and the double cyanide of gold and potassium is now the favorite solution of gold used in gold plating. That a dilute solution of cyanide of potassium would extract gold and silver from their combination in sulphurets of iron, etc., leaving the sulphurets apparently unchanged by this treatment, was certainly an amazing statement, and justified to a great extent the incredulity with which chemists received the article, and the refusal of many of them to test the truth of the statement for their own satisfaction.

The writer confesses to having shared in the doubts of the majority, and for a time looked upon the subject as a companion of the schemes attempted to be palmed off on our capitalists by Alfred Paraf, of oleomargarine fame; Major Tichenor, of Calistoga notoriety; Robertson (alias potassium cyanide), of San Francisco; and the "green gold" swindlers of San Rafael.

The "Paraf" scheme consisted in the discovery of tin ore on the Potrero adjoining the city of San Francisco on the south. In 1875 he had some of the newly made "Bonanza Kings of the Comstock" in a high state of joyful mental excitement; one of them was carrying in his vest pocket little buttons of tin that he had seen smelted from the Potrero rock by the cunning Paraf and his mysterious process. The regular chemists of the city, not being able to extract tin from the "Paraf tin stone," were for a time under a cloud. Paraf was finally cornered into smelting some of his ore in a chemist's laboratory, his secret of extraction being in the use of a liquid (which he called pure glycerine) as an ingredient in the fluxing.

The experiment was tried in the presence of one of the "Bonanza Kings," but Mr. Paraf was not allowed to handle the fluxes and, to his chagrin, the addition of glycerine failed to produce a tin button. Paraf went to a well known drug store and brought back a bottle labeled "pure glycerine" and wanted to try it over with his liquid; the bottle was seized and the glycerine found to be a saturated solution of chloride of tin. This explained very satisfactorily the source of the successful results in his assays, but at the same time prevented the transfer (to use a slang phrase current in this part of the world) of any of the capitalist's "tin" to Paraf's pocket.

Major Tichenor's wonderful discovery was that the water of the springs at Calistoga contained gold, in the form of "terchloride" and was readily precipitated by the addition of proto-sulphate of iron.

Notwithstanding the absurdity of this claim and its ready exposure by the State Mining Bureau almost in its infantile stage, numerous people, with more money than brains, readily purchased interests from the smooth-talking Major Tichenor.

About 1880 Robertson entered the field with a wonderful discovery, which yielded results in Robertson's hands that caused people's eyes to open with astonishment, and in some cases their purses also.

His "process" was to heat the quartz in lumps in a muffle; then drop it while hot into a solution of cyanide of potassium; crush, grind, and amalgamate it, when he invariably found gold. The fact that he was manipulating rock that did not carry any gold that a fire assay could detect

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did not at all interfere with his obtaining very respectably sized lumps of amalgam, which upon retorting showed the yellow gold.

But that the gold was due to Robertson, and not to any special merit of his process, was shown by the fact that a manipulation of the rock carried out by the writer under Robertson's own instructions and personal supervision (except that Robertson was not allowed to get close enough to exercise any legerdemain) failed to yield any gold.

The "green gold" scheme of San Rafael, which depleted the purses of some of our citizens who doubtless have often since smiled at their credulity, consisted in the claim that a ledge in Marin County contained paying quantities of gold, but in a "green" state—that is, it was not yet fully matured into metallic gold, which maturity, however, certain parties, by a secret process, could bring about in short order.

This "green" or "youthful" gold had the unfortunate property of escaping detection by the ordinary assayer, because, as they asserted, of a lack of knowledge to flux it properly so as to render it "mature," and consequently visible. One of the secrets of their fluxing that they were willing to give to the public was that the presence of traces even of common salt in the fluxing would cause this "green gold" to volatilize. This information spread so rapidly in the early part of the last decade that it was not at all uncommon for assayers to be requested by customers not to put any salt in their crucibles as a part of the fluxing.

The stock in this company found many purchasers; but it is needless to remark that the only "green" gold that ever matured was that portion that was taken from the "green" investors' pockets.

In the first experiments on the Macarthur-Forrest process, made in the laboratory of the State Mining Bureau, the sulphurets treated with a 1 per cent solution of cyanide of potassium only yielded 40 per cent of the assay value. Upon investigation the sulphurets were found to contain free gold, and after treatment with the cyanide solution free gold was found by carefully panning.

This induced us to make experiments as to the solvent action of dilute cyanide upon metallic gold.

In all the experiments the actual percentage of cyanide of potassium in the salt used was determined, the percentage varying from 45 to 71 per cent, and sufficient of the commercial cyanide was taken to make the actual cyanide present equivalent to 1 per cent.

With this 1 per cent solution it was found that one hour was sufficient to dissolve gold leaf, such as is used by sign writers. Reflecting, however, that gold in nature in the rock was very seldom found in such an attenuated state, the experiments were repeated on gold foil such as is used by dentists, being, as nearly as I could approximate by measuring and comparing by weight, about six times as thick as the gold leaf first used.

The shortest period of time in which gold foil of this thickness was dissolved was forty-eight hours. The deduction from these experiments was that for the solution of free gold in particles of an appreciable size in a dilute cyanide solution, the new process was not a success.

Our attention was then directed to its action upon the gold contained in sulphurets. The sulphurets used in the experiments were typical of those worked by the chlorination works at Sutter Creek, Amador County, and contained five and one tenth ounces of gold.

Taking the sulphurets in the same condition as regards fineness of

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division as they are used in the chlorination process and digesting with one per cent cyanide, partly by percolation and partly by agitation; the following results were obtained:

After two hours' treatment tailings contained 35.29 per cent of the gold.
After three hours' treatment tailings contained 31.37 per cent of the gold.
After four hours' treatment tailings contained 30.37 per cent of the gold.
After six hours' treatment tailings contained 25.49 per cent of the gold.
After eight hours' treatment tailings contained 21.56 per cent of the gold.

The same sulphurets ground and passed through a "100" sieve after six hours' digestion, had left in the tailings 17.64 per cent of the gold.

To determine whether the dilute cyanide was capable of extracting all the gold present in these sulphurets, the following experiment was made: The ore was ground to an impalpable powder in an agate mortar and digested for forty-eight hours with three different solutions of 1 per cent cyanide; the tailings were found to retain 9.80 per cent of the gold.

Another lot of sulphurets from which the "free" gold had been removed with extreme care were subjected to the following experiments: The ore was passed through a "120" sieve and digested with a 1 per cent solution of cyanide of potassium.

After two hours' treatment tailings retained 31.2 per cent of gold.
After three hours' treatment tailings retained 28.5 per cent of gold.
After four hours' treatment tailings retained 15.6 per cent of gold.
After five hours' treatment tailings retained 15.5 per cent of gold.
After eight hours' treatment tailings retained 10.4 per cent of gold.

The "float slimes" from a $500 gold ore (the "slimes" assaying 5.3 ounces gold) treated for six hours with a 1 per cent solution of cyanide, yielded the best results of any of the experiments, the tailings retaining only 4.71 per cent of the gold.

In regard to the precipitation of the gold from its solution in cyanide of potassium by the aid of metallic zinc, experiments on the small scale in the laboratory appear to substantiate the claims made for this part of the Macarthur-Forrest process.

The "Macarthur-Forrest" process must be regarded as a valuable addition to the metallurgy of gold and silver. Being yet in its infancy, and opening up as it does a new line of investigation and research, improvements may rationally be expected.

As noted above, the most marked success is attained when the ore is in an impalpable powder, and the precious metals in combination with the sulphurets.

From our experiments we feel convinced that in our next report we will be able to chronicle some very marked and valuable discoveries in this direction.

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RINCON HILL WELL.

FOLSOM AND SECOND STREETS. GEOLOGICAL SECTIONS AS SEEN IN SINKING.

Messrs. Boyd & Davis, finding that the lessees of their large building on the southeasterly corner of Second and Folsom Streets, in San Francisco, Messrs Kohler & Frohling, would require a very large amount of water daily in their business, undertook for the benefit of their lessees, the sinking of a deep well in the form of a shaft, in the southeasterly end of said building, which they carried down to a depth of two hundred and fifty-two feet, when, not having met with water, they started a drift to cross the formation. One of the owners, who is likewise at the head of the Board of Trustees for the State Mining Bureau, drew the attention of the officers of that institution to the work being done, as likely to furnish some interesting data, toward the knowledge of the geology of the peninsula on which the city is built. It was therefore visited by employés from that institution at different times during the progress of the work, to note the changes encountered. The data thus obtained will be found embodied in the following remarks on the geology of this part of the peninsula of San Francisco.

Starting out from the lowlands bordering on the northern edge of Lake Merced, a series of parallel hills and ridges course to the northeast, terminating on the shores of the bay of San Francisco. These ridges are composed largely of highly metamorphosed cretaceous formations, derived from alternating strata of sand and mud, supplied through the mechanical action of the ocean waves, and the erosions and decompositions of the eruptive rocks, these materials being carried down by streams and deposited in comparatively still waters. These stratified deposits were at later periods subjected to various gradual upheavings and settlements known to have occurred on this coast, in the course of which actions they became not only highly metamorphosed, but also largely distorted and folded, dipping in all directions and angles.

These alternating strata show very distinctly the changes that have taken place from the original sands and magnesian muds, as deposited, to the present changed sandstones and the contorted schists and serpentines that are yet undergoing alterations in Nature's laboratory.

Where these muds have been infiltered by silicated solutions and subjected simultaneously to a slow, constant pressure, they have been altered to slates, which can be seen on the summit of one of the northern faces of Telegraph Hill. Where other infiltering solutions have penetrated the sands, we find a chert that contains traces of magnesia. Where the clays, containing but little magnesia, but with an excess of sand, have been subjected to these infiltering solutions, they are converted into jaspery slates.

Extending from these principal axial backbones are spurs or lateral ridges, reaching out toward the bay, portions of which, as well as parts of the main series, have been denuded and eroded, forming islands and estuaries. From some of the indications, it is not unlikely that the erosions have been caused in part by glacial action. These depressions again filled with sand and magnesian muds, at later epochs were, with the entire system of ridges and valleys, uplifted; and it is in these last upheaved deposits adjoining the present true bay shore that the well was sunk, to which, with its exposures, we wish to call attention.

The part known as Rincon Hill has its longer axis coursing northwest and southeast, abutting on the bay near the present wharves of the Pacific Steamship Company. It has been largely leveled off for suitable building sites, showing some good exposures. On its northwestern slope, on Second Street, going from Harrison to Folsom Street, it shows fine-grained sandstones intruded by stratum of talcose slates. On the southeastern side, facing the bay of San Francisco, is a bold bluff of coarse-grained sandstone, interstratified with layers of finer grained, showing the changes in the force of the currents at the time of their deposition. On Folsom Street a broader band of highly distorted slates flank the sandstone.

The well is sunk to the depth of two hundred and fifty-two feet, with a rectangular section four feet by six feet, thoroughly timbered and closely lined with planking. At seven feet from the bottom the drift was started in a northerly direction. The sinking was commenced in the slatey formation abutting the sandstone bluff, the slates dipping to the southeast at an angle varying from 60 to 70 degrees into the sandstones, the face of which dipped at an angle of 85 degrees towards the slates.

When a depth of one hundred and twenty feet was reached, the well having been all the time approaching nearer to the sandstone, bowlders of the same were encountered, as intrusions in the slate, down to the level of the drift, two hundred and forty-five feet from the surface. The drift was then started northeast 65 degrees through the slate, and for a short distance, about ten feet, these small sandstone intrusions were still found, having undoubtedly broken away during the time the bluff had formed the shore-line and imbedded themselves in what was then the mud bottom of the lagoon. The slates kept their pitch toward the shaft in the drift for a distance of one hundred and seventy feet, where the evidences of a crushing became very apparent for a distance of thirty feet, and they assumed all kinds of angles; while the interstices formed by the bending and rupturing of the strata were found to be filled with small seams of calcspars, and the slate itself impregnated with small crystals of iron pyrites and small veins of quartz. After leaving this fault, the strata were found to be dipping away from the shaft for a farther distance of one hundred and twenty feet, proving that what had been passed through by the drift was the upper part of an anticlinal fold.

In the next thirty feet the strata showed much distortion, but finally settled to its former pitch towards the shaft. After continuing the drift about sixty-five feet, and giving it a gentle curve to the northeast along a distance of about sixty feet, a second and greater crush was encountered, which shows in the drift for a length of fifty feet. In it the changes that have taken place are more pronounced; some of the crushed slate has been reduced to clay, while other parts have become saturated with silicated solutions and show seams of quartz. The sandstone bowlders that are encountered are here highly altered, showing serpentine, spar, and iron sulphides. Some of the slate has been con-

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METEORITES.

By F. C. von Petersdorff, E.M.

Metallic iron occurs in Nature comparatively rarely and hardly ever in sufficiently large deposits to make it of industrial value. By far the greater part is derived from extra terrestrial sources and known as meteoric iron.

It consists of metallic iron, nickel, cobalt, copper, graphite, and other metals and minerals, some of which have entered into chemical combinations not existing in any terrestrial mineral, as for instance:

Asmanite, a species of silica.

Daubreélite, sulphide of iron and chromium.

Laurencite, proto-chloride of iron.

Maskelynite, a singly refracting mineral with the composition of labradorite.

Oldhamite, sulphide of calcium.

Osbornite, sulphide of calcium and titanium or zirkonium.

Peckhamite, a silicate of iron and magnesium.

Schreibersite, phosphate of iron and nickel.

Troilite, sulphide of iron.

Meteoric iron is frequently found in considerable masses, as will be seen from the following instances:

A meteorite discovered near Bahia, Brazil, weighed fourteen thousand pounds; another one, found near the village of Chaco-Gualamba, Peru, is estimated at thirty-two thousand pounds, and still another, in Siberia, weighed one thousand six hundred pounds. Pieces weighing in the neighborhood of one hundred pounds are of comparatively common occurrence.

Two specimens of these interesting cosmic bodies are on exhibition in the museum of the California State Mining Bureau.

One of them was found in Ivanpah Mining District, San Bernardino County, California, and weighed, before cutting, one hundred and twenty-eight pounds three and one half ounces (it was cut in order to produce Widmannstättian figures); the other one is from Portage Bay, Chilcat Inlet, Alaska, and weighs ninety-six and three fourths pounds.

Besides these comparatively rare large pieces, there falls a constant rain of cosmic iron dust upon the earth, which fact has been observed on the vast snowfields of northern Sweden and Siberia, and also by deep-sea exploration, as, for instance, by the "Challenger" expedition. It is only under conditions such as these that it is possible to detect finely divided meteoric iron, in consequence of the enormous accumulation, elsewhere, of terrestrial iron dust.

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ANALYSIS OF SEVERAL METEORIC IRONS.

	Brazil.	Siberia.	Tennessee.	California.	Alaska.
Iron	63.69	88.04	91.15	94.98	92.56
Nickel	33.97	10.73	8.01	4.52	7.11
Cobalt	1.48	0.46	0.72	....	0.12
Copper	0.05	0.07	0.06	....	trace.
Manganese	....	0.13	....	....	....
Carbon	0.02	0.04	....	0.10	trace.
Sulphur	0.02	trace	....	....	0.40
Phosphorus	0.05	....	....	0.07	0.12
Silicate	....	0.53	....	....	....
Totals	99.28	100.00	99.94	99.67	99.95

Native iron of terrestrial origin occurs in minute particles finely disseminated through the basalt forming the Giant's Causeway in the north of Ireland, also in limestone in Bohemia, in Keuper sandstone in Thuringia, and in old lava in the Auvergne. Some has also been discovered recently near Silver Lake, Lake County, Oregon. The only locality where it has as yet been found in large quantities is the island of Disko, off the west coast of Greenland, where Nordenskjöld found what he believed to be the largest meteorite ever discovered.

It was a mass of solid iron, which he estimated to weigh not less than forty-two thousand pounds; near it lay another one, weighing about sixteen thousand pounds, and several smaller pieces; in fact, the entire shore was strewn with iron pebbles, varying in size from a mustard seed to a cocoanut.

Most of these pieces of iron presented the usual features of meteoric iron in their outward appearance as well as in their chemical composition; for which reasons Nordenskjöld considered them to be of cosmic origin, but a careful examination of the locality revealed the startling fact that they are, without exception, terrestrial, and weathered out of a huge bed of basalt, extending for miles inland and containing metallic iron in abundance.

AN ANALYSIS OF THIS IRON BY NORDENSKJÖLD.

Iron	84.49
Nickel	2.48
Cobalt	0.07
Copper	0.27
Carbon	10.62
Sulphur	1.52
Phosphorus	0.20
Chlorine	0.72
Silicate	0.09

Meteoric iron may be easily distinguished from artificially produced iron in the following way:

On the metal to be treated is produced a smooth surface, to which are applied a few drops of nitric, sulphuric, or hydrochloric acid, when at once peculiar lines, intersecting under certain angles, will make their appearance in case the iron is meteoric.

These lines or figures are named after their first discoverer, Widmannstätten, and are caused by a crystalline structure of the iron and the fact that meteoric iron is always alloyed with more or less nickel, cobalt, or copper, etc. To understand the formation of these lines or

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figures it must be remembered that crystallization is to a certain degree a purifying process, upon which fact is based, for instance, the Pattinson lead-desilverizing process.

Now, when a mineral crystallizes, it endeavors to expel all foreign substances mixed with it by driving them towards the periphery of the nascent crystal, thus forming a coating around it, which is sometimes of surprising uniformity. In case the crystallization process is from time to time interrupted and resumed at a later period, several zones of foreign substances are formed, each one representing the outline of the crystal at a certain stage of its growth. This is frequently the case in meteoric iron.

Careful angle measurement shows that these lines are due to crystallization in the octahëdral system, while another set of lines, discovered by Neumann, denotes cubical crystallization.

THE ORIGIN OF METEORITES.

In former times it was thought that meteorites were of terrestrial origin, thrown out by volcanoes, or condensed vapors, or else that they hailed from the moon.

These suppositions do not hold good when we consider the enormous initial velocity, the great number, direction, and periodical recurrence of these phenomena. For the same reasons, is it impossible that they should be fragments of a destroyed satellite—a second moon—supposed to have revolved around our planet in past ages, or yet that they are diminutive, independent planets of our solar system.

The hypothesis that they are identical with shooting stars and comets is the one accepted almost universally by scientific men.

Most important discoveries tending to prove this assumption were made by Schiapparelli, showing that shooting stars, as well as meteorites, are solid bodies which enter the atmosphere of our earth with an immense velocity and become luminous, because of the resistance offered by the air.

It has been calculated that they usually appear at a height of about seventy miles above the earth, and disappear at a height of fifty miles. The cause of their disappearance or extinguishing is to be looked for either in their once more leaving our atmosphere, or that they are atomized by the fierce heat generated by their extremely rapid flight and the great resistance offered by the atmosphere. The latter assumption would account for the continuous fall of cosmic dust upon the surface of our globe.

The velocity with which they enter and pass through our atmosphere is enormous. It is many times faster than sound, the flight of a cannon ball, and even the planets revolving around the sun.

The earth travels through space at the rate of nineteen miles per second. Mercury, the fastest planet, covers 29.87 miles per second, while a meteorite, which fell at Pultusk, Russia, had a velocity of 33.78 miles per second, although it had to overcome the resistance of the air. In space, consequently, it must have traveled still faster.

To clearly understand the high degree of velocity implied by these figures, it is well to add that the fastest cyclone scarcely reaches one hundred and fifty feet per second, at which rate it exerts a pressure of about fifty pounds per square foot.

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eight years; the Leonides once every thirty-three and one quarter years, or three times per century.

Knowing thus the direction, the velocity, and the time of rotation of the several meteoric streams, as well as the common focus of their orbits—the sun—it is not difficult to calculate their trajectories, which show a most intimate connection with those of periodic comets.

The trajectory of the Perseides coincides with that of the third comet of 1863. The same connection exists between the Leonides and the first comet of 1866; the stream of April twenty-second and the first comet of 1861; and the stream of November twenty-seventh and Biela's comet.

The same connection has been proved to exist between a number of other meteoric streams and comets, justifying the hypothesis that these comets are constituent parts of the respective meteoric streams.

The possibility of a comet being disintegrated and more or less destroyed by the influence of the sun or one of the larger planets, has been proved in the case of Biela's comet, which fell into two parts in January, 1846, and other similar occurrences.

The fragments of cosmic matter resulting from such an event distribute themselves, according to the rules of mechanics, along the orbit of the comet, which they continue to follow, thus forming a meteoric zone, which, if crossed by the earth, furnishes material for shooting stars and meteorites.

It now remains to explain the assumption that meteorites and shooting stars are identical, and to quote the facts upon which this assumption is based.

We know that both are solid bodies, which enter our atmosphere from without, and that they become luminous for the same reason. Furthermore, the cosmic iron dust observed in localities where its origin could not be doubted has been found to have the same chemical composition, as larger pieces of meteoric iron seen to fall by unimpeachable witnesses.

It cannot be denied that there is a very great contrast between the little star that silently glides through space and noiselessly disappears, and the terrifying appearance of a ball of fire, that, approaching with deafening detonations, sends down on us a hail of stones.

Both spectacles, however, are but the extremes of a chain of closely connected phenomena. Considering with what an extreme velocity these bodies pass through the atmosphere, it is not difficult to comprehend that small particles, and those having the greatest momentum, are destroyed long before they ever reach the earth, and at such a height, that the noise of their passage and disintegration becomes inaudible to us here below.

We find a further confirmation for the belief that both of these phenomena have the same source in the well established fact, proved in many instances, that the direction of the meteorites corresponds to that of shooting stars observable at the same time, and points to a common point of radiation.

If it has been proved, nevertheless, by carefully kept records, that the fall of meteorites does not appreciably increase during our annual passage through the Perseides or Leonides, for instance, this fact might be cited as a contradiction of the hypothesis advanced. Careful consideration, however, proves it to be of no significance whatever, as will be seen from the following:

Digitized by Google

INDEX.

A

Digitized by Google

B

Digitized by Google

C

Digitized by Google

D

Digitized by Google

E

Digitized by Google

Digitized by Google

G

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

M

Digitized by Google

Digitized by Google

Q

R

Digitized by Google

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Santa Clara County 1889

"The Pyler well, sunk a year ago, ... has been abandoned after reaching a depth of over 1400 ft, on account of the tools getting stuck and defying every effort to remove them." p 54

"Well #9 has been sunk to a depth of 16 hundred ft." p 54

"During the present autumn Well #10 has been started in the gulch." p 54

9th Annual Rep

Calif.

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... 6 1914

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