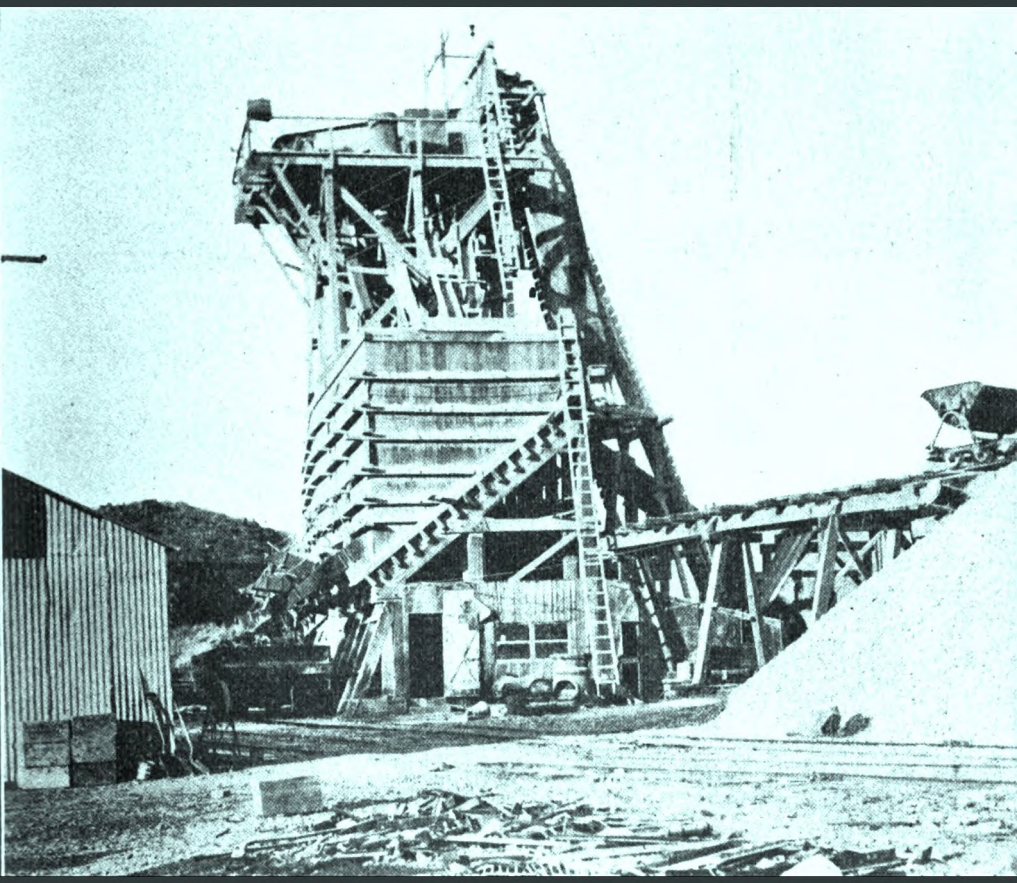

Geology and mineral resources of San Diego and Imperial ...

Frederick James Hamilton
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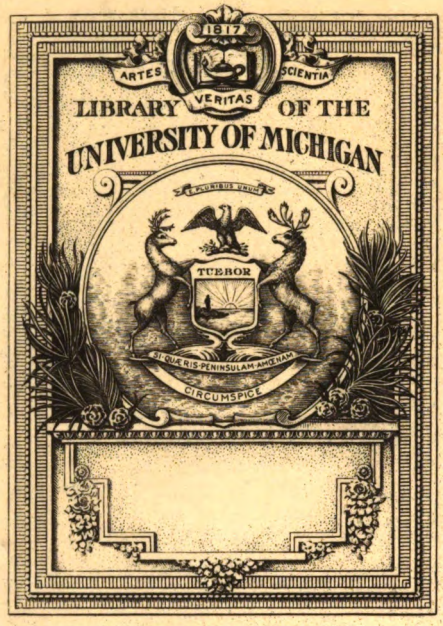

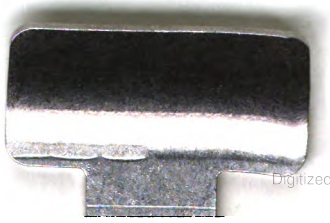

CALIFORNIA STATE MINING BUREAU
SAN FRANCISCO, CAL.

F. McN. HAMILTON, State Mineralogist

Geology and Mineral Resources

OF

San Diego and Imperial Counties

By Frederick J. H. Merrill, Ph. D.

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CONTENTS.

ERRATA.

Page 9, top line in Table of Formations, for *"San Pablo"* read *"San Pedro."*
" 31, in Section of Stonewall Mine, for *"chute"* read *"shoot."*
" 37, line 2, for *"NIO"* read *"NiO."*
" 37, line 3, for *"FEO"* read *"FeO."*
" 46, last line, for *"per day"* read *"per year."*
" 50, line 7, for *"per day"* read *"per year."*
" 51, line 1, for *"sand tracks"* read *"tracts."*
" 55, line 27, for *"plant"* read *"plants."*
" 58, line 7 from bottom, for *"hespects"* read *"respects."*
" 58, line 4 from bottom, for *"is strength"* read *"in strength."*
" 60, lines 2 and 3 from bottom, for *"tufa"* and *"tufas"* read *"tuff"* and *"tuffs,"* respectively.
" 68, line 9, for *"pocket"* read *"pockets."*
" 84, line 2 below cut, for *"1,201"* read *"1.201."*
" 101, line 12. The Bay Horse was a Lode Claim. The data refers to the adjoining placer claims.
" 106, line 7, for *"on marble"* read *"of marble."*
" 107, line 6 from bottom, for *"4,000,000,000"* read *"4,000,000."*
" 113, last line of table under Author, for *"L. E. Aubury"* read *"Various."*
" 113, insert for the year 1901, Stephen Bowers, Ph. D., Reconnoissance of Colorado Desert Mining District, Bulletin, pages 5-19.

CONTENTS.

INTRODUCTION.

The county of San Diego and its former eastern extension, now known as Imperial County, comprise a section of southern California unique in climate, mineral resources and agricultural possibilities. The first of these subjects has become familiar to the tourist and health seeker and has had an important influence in building up the city of San Diego and the population of the surrounding country. The second, to which this report is devoted, is of great interest for its variety, and will be, in the future, as it has been in the past, a matter of substantial financial importance. The agricultural conditions are so inviting that they have attracted world-wide attention and have been so attentively considered that they need not be described in detail here.

The following report presents the result of nearly three months of field work in the two counties. In this limited time it was not possible to visit every locality, but, by combining the writer's personal observations on the principal properties with other data from reliable sources, all deposits, of any importance or interest, have received attention and are accurately recorded.

In discussing the resources of these two counties, it seems advisable to treat them in two separate chapters, though their union prior to 1907 and their intimate relation in geography and geology, make it necessary to refer frequently from one to the other. Articles on the geology and mineral resources of San Diego County, together with Imperial County, are to be found in many of the publications of the State Mining Bureau, and to them the reader is referred for a large amount of historic detail. Reference to these will be found in the bibliography at the end of this report.

Acknowledgments for important assistance rendered are due to General A. W. Vogdes, Messrs. C. E. Anthony, J. G. Naylor and W. H. Trenchard, of San Diego, to Mr. Walter Nordhoff, of National City, to Mr. D. F. Lane, of Julian, and to many others.

Dr. A. S. Eakle of the University of California has made petrographic determinations of a number of rocks from the granite quarries, from the gem localities and from the Dulzura gold belt.

CHAPTER I.

SAN DIEGO COUNTY.

HISTORY.

The region of San Diego was first made known to the civilized world by the discovery of its bay in September, 1542, by Juan Rodriguez Cabrillo. By the arrival there on June 16, 1769, of Padre Junipero Serra and the establishment in honor of San Diego de Alcala of the first Franciscan Mission in California, this place was fixed as an important landmark in the settlement of the Pacific coast, and claims special prominence in the history of the Golden State.

The county bearing this name, with a present area of 4,221 square miles and a population in 1910 of 61,665, was one of the original twenty-seven counties organized in 1851 by act of the state legislature. At that time it was of much greater extent, its area having been considerably diminished, in 1889, by the separation from it of a part of what is now Riverside County. In 1907 it was still further reduced by the organization of its eastern portion as a separate county under the name of Imperial.

PHYSIOGRAPHY.

The county is diversified in its physiography, its essential topographic features being an area some 50 miles broad, of parallel ranges of granite, with southeast trend, including the southeastern continuation of the San Jacinto Range of Riverside County. Among these granite ranges are valleys occupied by parallel belts of metamorphic rock, chiefly slate and mica schist, with some quartzite and limestone, having nearly vertical dip and northwest strike, and extending, with many interruptions by granite intrusions, from Mexico into Riverside and Orange counties. About 40 miles northeast of San Diego, in a belt extending northwest and southeast, the altitude of the ranges exceeds 5,000 feet at many points, and some mountains attain greater elevations, as follows: Palomar, 6,126 feet, Hot Springs Mountain 6,400 feet, Cuyamaca 6,515 feet and Laguna Mountain 6,500 feet. These last two are intrusions of diorite or gabbro which, as the geologic map shows, occur here and there in the granite area. Southwesterly from this elevated belt the altitudes decline toward the coast. On the seaward border of the granite, extending northwest some 40 miles from the Mexican line, but only a few miles wide, is an area of volcanic felsite and tuffs, for the most part buried beneath the mesa formations, but exposed at many points and forming the mountain peaks of Otay, San Miguel, Black Mountain and others. On the west flank of all the crystalline formations, lies an extensive mesa or plain of Tertiary deposits, prominent in the landscape near San Diego and gently sloping seaward, from an altitude of about 500 feet at its eastern margin, to

an elevation of about 300 feet near the coast line. Thus, between La Mesa and La Jolla, its slope is about 20 feet per mile. From the main divide the surface slopes steeply eastward toward the Salton Basin, and here desert conditions prevail, since the precipitation mostly falls on the western slope.

Many observers have commented on the fact that the slope of the granite ranges is steeper toward the east than toward the west, for they rise abruptly some thousands of feet from the comparatively level and low lying Tertiary and Quaternary formations of the Salton Basin. Some have attributed their escarpments wholly to faulting, but, on examination of the region, it seems inadvisable to adopt this as the sole explanation. West of the Salton Basin, which is evidently in a syncline, though possibly on a fault line also, is an anticlinal area including minor synclines and having for its main axis, the granite of the peninsular range which trends nearly northwest. The northeast limb of this principal anticline is much steeper than the opposite one which declines toward the ocean. The various anticlinal and synclinal folds are intersected by parallel faults at right angles to their axes and consequently with northeast trend. These faults have cut the formation into blocks which pitch northwesterly. From the relation of the crystalline rock masses on the west side of the Salton Basin to the fossiliferous Miocene Tertiary beds it is evident that a local uplift of some 2,000 feet has occurred later than the Miocene period and probably in the Postpliocene and, to this uplift, in part, some of the more noticeable escarpments owe their present altitude.

GEOLOGY.

The following synopsis of the geology of the county is a brief résumé of what is known of its structure and history, no complete geologic survey having yet been made:

Under the first geological survey of California, conducted by Dr. John B. Trask from 1851 to 1856, no work was done in San Diego County.

In November and December, 1853, Mr. Wm. P. Blake, as geologist of the expedition under Lieut. R. S. Williamson, to determine a route for a transcontinental railroad, made a careful reconnaissance of the Salton Basin, and traversed the valley of Carrizo Creek through Vallecito to San Felipe and thence to San Diego. The results of his important work are to be found in volume V of the Reports of the Exploration, issued as Senate Document No. 78 of the Thirty-third Congress, second session. Prof. Wm. P. Blake also contributed to the Report of the Superintendent of the Coast Survey for 1855, pp. 376-398, an article entitled "Observations on the Physical Geography and Geology of the Coast of California from Bodega Bay to San Diego."

In December, 1857, in connection with the expedition for the exploration of the Colorado River under Lieut. J. C. Ives, Dr. J. S. Newberry crossed the country from San Diego to Yuma. His observations, made

in this journey, are on pages 13–18 of the report of the expedition, which is House Document No. 90, of the Thirty-sixth Congress.

Under the Second Geological Survey of the State, in 1872, W. A. Goodyear made a reconnaissance of the county, but his notes were not published until 1888. See Eighth report State Mineralogist.

In 1882 H. G. Hanks, State Mineralogist, visited the Colorado River Desert, as described in the second report.

In 1892, H. W. Fairbanks made a reconnaissance of the county over its principal highways, and his accurate observations appear in the eleventh report.

In all of the reports subsequent to the fifth are published notes on the mineral resources, and these embody geological observations.

In the limited time allotted to the writer for a study of the mineral resources of the county, he has noted all geologic details which came within his observation in visiting the chief areas of production. The sum total of all these observations, combined with facts gleaned in the study of neighboring areas, gives opportunity for a fairly accurate résumé.

It is hoped that the following review of the geology will have a stimulating effect on teachers and students within the county and in its neighborhood, and lead them to make further contributions to our knowledge of the structure of the region.

Table of Geologic Formations in Southern California.*

Period			Subdivisions	Local
	Pleistocene		San Pablo	
Cenozoic, Tertiary	Pliocene		San Diego	Fernando
	Miocene	Upper	San Pablo	
			Santa Margarita	
		Lower	Monterey	Modelo
				Puente
			Vaqueros	
	Oligocene		Sespe	
	Eocene		Tejon	
			Martinez	
Mesozoic	Cretaceous		Chico	
	Lower Cretaceous, Comanchean		Horsetown	
			Knoxville	
	Jurassic		Franciscan	San Luis
	Triassic			Santa Ana
Paleozoic	Carbonic and possibly older		Calaveras	Julian?

*In part after Ralph Arnold. Bulletin Am. Inst. Min. Engineers, March, 1914, p. 406.

Historical Geology.

The general geologic history of this county, so far as it can at present be read and written, is as follows:

No Palæozoic sedimentary rocks in which fossils are preserved are known within the county, but from evidence collected at various points[1] concerning the metamorphic strata of the Mother Lode region and from Carbonic fossils[2] found in the Santa Ana Mountains of Orange County, we conclude that, as early as Carbonic time, and possibly earlier, shoal water conditions existed over parts of San Diego County, leading to the formation of extensive deposits of mud and sand, derived from the erosion of some adjacent continental area. These beds possibly rested on a basement of granitic material, though we are not certain of this, and in them, at intervals, thin deposits or lenses of carbonate of lime were formed. At some time subsequent to the Jurassic period, came an epoch of mountain building, during which the rock mass underlying the sediments, above mentioned, in a molten state and under great pressure; or granite from some other source, in a state of fusion, was forced upward in parallel zones of northwesterly trend. In this movement, through the attendant heat and pressure, the overlying sediments were metamorphosed, mud deposits becoming slate and mica schists, sand beds becoming quartzites and limestone being crystallized into marble. In addition, these beds were thrown into folds, anticlinal above the granite axes and synclinal in the troughs between, in the latter, the strata being so closely compressed as to stand nearly vertical. In the lapse of subsequent time, through long erosion, the metamorphosed sediments overlying the granite, have been worn away, leaving the igneous crystalline rocks uncovered in the principal mountain ranges; while the schists, slates, quartzites and limestones have been preserved in the valleys.

Subsequent to this period of mountain building, came a prolonged subsidence of the coast, during which, on the flanks of the upland, sedimentary beds were deposited in intermittent sequence from the Cretaceous through the Tertiary. As Miocene beds are not evident on the west slope, their deposition may have been interrupted by temporary emergence of the land. In the Salton Basin, however, the Miocene is represented by extensive clay deposits, well exposed in the region of Carrizo Creek and bearing proof of their age in the very noticeable bed of Miocene oyster shells (*Ostrea vespertina, Con.*) which caps them.

At the close of Miocene time, after attaining a maximum of 1,500 feet or more on the coast and 2,000 feet or more in the Salton Basin, the subsidence in the latter was suspended while that of the coast continued into Pleistocene time. Then began a gradual emergence causing

[1]See Mother Lode Folio, U S. Geological Survey. Also San Luis Folio, U. S. Geological Survey.

[2]H. W. Fairbanks, R. XI, p. 116. Later studies of these fossils suggest their Triassic age, and modify our views concerning the Santa Ana metamorphic strata.

the deposits formed during the submergence to be exposed to wave action at successive levels, for the rise of the continental margin was not continuous but intermittent. In the periods of no movement or of less movement, were cut and formed the various mesas, sea terraces and shore lines, which are so conspicuous in the scenery of the coast of southern California. The unequal height of some of these terrace planes shows that the movement was not everywhere the same. The elevation of the land progressed considerably beyond its present limit, and evidence from various sources indicates that the continental margin rose 800 to 1,000 feet higher than it stands at present and since then has gradually subsided. Evidence of the latter movement is seen everywhere along the coast of San Diego County, in the drowned stream valleys, often occupied by salt marshes. Of the periods of volcanic activity little is known except that considerable material of igneous origin has been deposited.

Structural Geology.

The formations of San Diego County are granites and other igneous crystalline rocks of several ages, metamorphic strata of great age, possibly Carbonic or older, and sandstones, shales, conglomerates, sands, gravel and clays of Mesozoic and Tertiary age.

The granites upon which the metamorphic rocks rest and by which they are intruded, are of several types, some of which Dr. A. S. Eakle has identified and his descriptions will be found under the various quarries. These granites in turn are intruded here and there by basic rocks of the diorite and gabbro types. The latter are cut, at many points, by pegmatite dikes which also sometimes appear as intrusives in the schists and in the granites. Two areas of these basic intrusives form substantial mountain ranges, one traversing the Cuyamaca Grant from north to south, and forming three peaks, of which the southernmost, 6,515 feet high, is known as Mt. Cuyamaca. Ten miles southeast, is the diorite ridge, known as Laguna Mountain, of which the summit attains an altitude of over 6,500 feet.

On the southwest flank of the granites is a volcanic area, a few miles wide, extending northwest some 40 miles from the Mexican boundary and often erroneously called "the porphyry dike." This is largely overlain by the Tertiary formations. The principal rocks exposed are felsite, quarried for crushed stone at Spring Valley and Sweetwater Dam. With these, at various points, are tufas and volcanic conglomerates. The age of these volcanics is as yet somewhat indeterminate, but the specimen from Lo Tengo oil well, of black shale cut by felsite, suggests a post-Jurassic age for the latter. Dr. A. S. Eakle has made a petrographic examination of the felsite from Spring Valley and Sweetwater, and his results are as follows:

Sweetwater quarry. Metarhyolite or felsite. A thin section shows a feldspathic polarizing base filled with needles of feldspar, showing flow

structure and pale green chloritic matter filling the interstices. Patches of yellow granular epidote, as an alteration product, are frequent. A grayish opaque dust is sprinkled throughout.

Spring Valley. Felsite. A thin section shows a fine indeterminate feldspathic base of needles with considerable green chlorite and altered opaque material.

The felsites may belong to the same period of eruption as the volcanics of Coyote Mountain in Imperial County, which underlie the Miocene clays, but they are of different type, for the Coyote Mountain effusive rocks are basic and, though they are badly decayed and difficult to identify, were probably mostly andesites.

The latest of the volcanics are probably the lava flows capping Tertiary gravels, seen in this county near Jacumba, and reported by H. W. Fairbanks[1] as occurring on the Santa Rosa Grant in Riverside County. They also occur near the coast south of the Mexican boundary. With these flows are deposits of tufa and conglomerate.

The metamorphic formations are mica schists, slates, quartzites and limestone, the first being especially well exposed near Julian and the latter occurring in small areas at several points. These metamorphic rocks, from their structural position and lithologic characters, may be regarded as probably equivalent to the Calaveras group, described in the Mother Lode Folio of the U. S. Geological Survey and will here be designated as the Julian group. Their exact age is uncertain.

A specimen of the Julian schist has been determined by Dr. Eakle as muscovite-schist. A thin section shows much quartz and slender frayed rods of muscovite. Much magnetite in grains and irregular masses, considerable limonite stains and an occasional apatite prism are seen.

The oldest unaltered sedimentary rock in the county appears to be a black slate which has been encountered in the Balboa, Lo Tengo and Otay oil wells and is exposed on the north slope of Mount San Miguel, on the west margin of the granite. A similar rock is found south of Dulzura in section 22. Here it contains a deposit of jasper. Lithologically it is similar to the material of the San Luis formation which has been identified in San Luis Obispo County as Franciscan or Jurassic (*see* San Luis Folio, U. S. Geological Survey). A fragment from the Otay well contained a small Avicula. Small outcrops of limestone are reported further northwest.

The Cretaceous strata exposed in this region are of the Chico series and appear in the bluffs on Point Loma and at La Jolla as described by Fairbanks.[2] Near the reservoir above La Jolla a specimen of Inoceramus whitneyi was found, which is now in the Chamber of Commerce Museum at San Diego.

As to the Tertiary, while the fossiliferous beds in and near San Diego

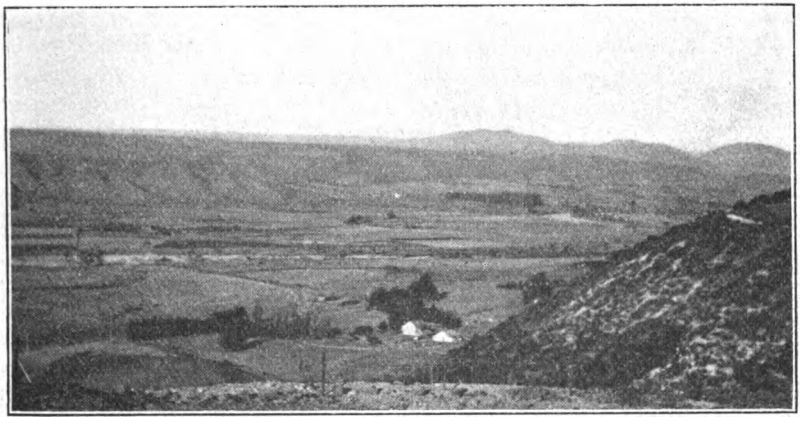
[1]Report XI, p. 101 *et seq.*
[2]Report XI, p. 95.

are chiefly Pliocene, Eocene fossils have been found in Rose Canyon, and, according to Fairbanks,[2] on Point Loma. Miocene deposits have not yet been identified west of the divide, but are well developed in the Salton Basin.

The Pliocene and Pleistocene formations, in stratigraphy and palæontology, have been fully described by Ralph Arnold.[3] To the average observer their chief physical character is manifest in their uniform surfaces which are known as *mesas* and therefore these merit the following description.

Mesa Formations.

As mentioned under Physiography, a prominent feature of the coastal region of the county, especially in the southwest, is the Mesa, a broad, elevated plain, gently sloping and deeply cut by stream valleys. To the layman this mesa is chiefly apparent by its relatively even surface with, here and there, a slight hummock or elevation, rising above its plane.



The Mesa and Mission Valley, Looking Northeast. F.J.H.M. Photo.

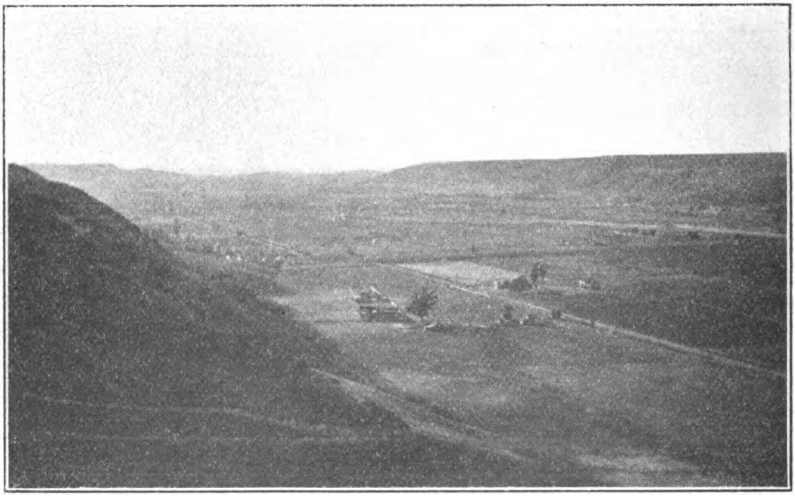
The geologist, however, also considers its materials as exposed in the banks of ravines and canyons and in cuts made in building roads. The superficial material, exposed from La Mesa westward along the side of Mission Valley and its tributaries, is seen to be chiefly a loosely cemented conglomerate 6 to 10 feet thick, underlain by finer materials of a sandy or clayey character.

On more careful investigation, the Mesa formations are resolved into two divisions: (1) An older mesa, much dissected by erosion, and largely washed away, the remnants of which, at the mouth of El Cajon Valley, reach a height of about 650 feet, and much greater altitude farther northwest; (2) A younger and less eroded mesa, of lower altitude, reaching in the same vicinity, a height of about 475 feet. The

[2]Report XI, p. 95.
[3]Palæontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, Cal. Mem. Cal. Acad. of Sc. Vol. III, 1903. Tertiary and Quaternary Pectens of California, U. S. Geol. Survey, Professional Paper No. 47, 1906.

latter is the principal feature of the landscape within 10 miles of the coast in the neighborhood of San Diego.

These mesas are remnants of waved-formed terrace plains, developed at such successive intervals in Tertiary time. The upper is probably Pliocene, while the lower may have been formed in the Pleistocene. The shore line of the latter is mainly carved on the deposits of the older mesa, though in places, it rests on the crystalline rocks which underline them both. The shoreline of the older mesa is quite irregular, extending into the reentrant of El Cajon Valley and into those of Escondido, San Bernardo and others. Its level is marked by patches of loose material and conglomerate on the valley sides and on the hills within the valley, their uniformity of level and material, denoting their common origin. As stated, near Grossmont, the height of a fragment of the older mesa is about 650 feet. On the road to Poway a similar



The Mesa and Mission Valley, Looking Northwest. F.J.H.M. Photo.

formation exceeds 1,000 feet. In the Escondido Valley it reaches 1,200 feet, and near the north line of the county it is still higher.

The elevation of the land or change of sea level, which raised the older mesa above the waves was much greater toward the northwest. At the national boundary the two mesas approximately coincide in level at about 500 feet above tide. On the other hand the younger or principal mesa seems to have its greatest elevation to the south. The Otay mesa has a surface height of 500 feet, while south of the Mexican boundary, the corresponding plain is higher.[4] Northwesterly its height declines until, near Oceanside, the principal mesa level seems to be about 300 feet.*

[4]W. A. Goodyear, R. VIII, p. 518.

*For other observations see A. C. Lawson, Postpliocene Diastrophism of the Coast of So. Cal., Bull. Dept. Geol. Univ. of Cal., Dec. 1893.

GEOLOGIC MAPS.

The map prepared in 1893 by H. W. Fairbanks, to accompany his report on the geology of San Diego and Riverside counties, published in the eleventh report of the State Mineralogist, is very accurate in its general expression of structure. The Geologic Map of North America, issued in 1912 by the U. S. Geological Survey, while in general correct, shows a subdivision of the Tertiary formations of the costal area of this county, which will not be attempted here since, in this region, the mapping of Tertiary boundaries is not at present possible.

TOPOGRAPHIC MAPS.

The topographic work of the U. S. Geological Survey has been carried over the larger part of San Diego County, extending from the coast line east to the meridian of 116° 30′ west longitude, which nearly coincides with the line between ranges 4 and 5 east of the San Bernardino meridian. The sheets or quadrangles covering this area are San Luis Rey, Ramona and Cuyamaca on the scale of 1 ÷ 125,000 or about ½ mile = 1 inch, and San Diego and La Jolla on the scale of 1 ÷ 62,500 or nearly 1 mile = 1 inch. Also, within the San Luis Rey quadrangle, are two on the larger scale known as the Oceanside and Escondido quadrangles, and within the Cuyamaca quadrangle, is one on the larger scale, known as El Cajon. Beyond these, the Indio Special Map, scale 1 ÷ 125,000, covers townships 9 and 10 south in ranges 5, 6, 7 and 8 east, San Bernardino meridian. Further, all the region west of longitude 116° 30′, or range 5 east, is shown on a map known as Southern California Sheet No. 2, on the scale of 1 ÷ 250,000, or nearly 1 mile = ¼ inch. A map of the whole county on the scale 1 ÷ 125,000 has been carefully compiled under the direction of the county surveyor, Mr. James Butler, and several other county maps are for sale by local dealers in San Diego, which have been mainly compiled from the sources above mentioned.

In compiling bases for the economic map, accompanying this report, the writer has used the work of the U. S. Geological Survey as far as it extended, and has followed the map of Mr. Butler for the eastern section. The detail of Imperial County has been largely taken from the Imperial County map prepared under the direction of Mr. C. N. Perry, county surveyor, and some topographic detail has been taken from the U. S. Geological Survey Sheet, known as A Reconnaissance Map of the Salton Sink. The township plats in the U. S. Land Office at Los Angeles have also been consulted.

The purpose of the map, accompanying this report, which is on the scale of 4 miles to 1 inch, is to show the configuration of the surface and the drainage, the lines of transportation by water, by steam railway or by motor truck and wagon and, more particularly, the exact location of all mineral deposits of economic interest, whether at present being worked or lying idle.

MINERAL RESOURCES.

GENERAL.

The following pages give a concise summary of the mineral resources of the county, based on all accurate information previously on record and supplemented by additional detail obtained by the writer in his survey of the principal mineral areas. Since the time available for field work was limited, the detailed study of some specially important deposits has necessarily been left to future investigation. At the present time, the mineral production of this county is more important in non-metallic minerals than in metals. This is due, both to the decline of gold mining and to the growth of the city of San Diego and neighboring settlements, which has led to the discovery and development of extensive deposits of materials used in construction and in the industrial arts. To a large extent, the mineral resources of this county are dormant, through lack of transportation.

THE METALS.

Though, at present, they are less important commercially, it seems advisable to discuss first the metallic minerals known in the county, beginning with that precious metal, of which the discovery in California, led so early to the development of our Pacific coast. Deposits of several other metals have long been known in the county, but have not been described in the annual and biennial reports. The discussion of the metals will be given in the following order:

1. Gold
2. Copper
3. Silver
4. Lead
5. Zinc
6. Iron
7. Manganese
8. Molybdenum
9. Antimony
10. Bismuth
11. Tin
12. Nickel
13. Tungsten

GOLD.

This precious metal is found at many points in San Diego County and has, unquestionably, been known since a very early period of occupation; but its deposits, while in many cases, richly productive, at the time of their discovery, have not been continuously operated. The gold production of this county, though in the past amounting to several millions of dollars, is at present entirely suspended. Further, the present depression in all branches of the mining industry and the difficulty of finding capital for the development of small mines, has discouraged prospectors and but little new work is being attempted.

On some old unpatented claims, assessment work is still being done, some patented properties are being explored, in a limited way, and a few new claims are being developed. Near Julian, by individual effort, a small amount of ore is being produced. Since many properties appear quite limited in the extent of their ore deposits, it is not probable that many large mines will be found in this county, or be developed in the

future; yet, several properties would well justify systematic exploration under expert supervision. It should be appreciated, also, that some mines have been and may continue to be, in the future, satisfactorily profitable under economical management at the hands of their owners, which might not be sufficiently productive to bear the heavier expense of operation by a corporation.

For previous records of gold mining in this county and in Imperial, see the following publications of the State Mining Bureau:

Report VI, Pt. 1, 1886, pp. 80–90;
Report VIII, 1889, pp. 512–516;
Report IX, 1889, pp. 139–154;
Report X, 1890, pp. 540–544;
Report XI, 1892, pp. 376–387;
Report XII, 1896, pp. 237–243;
Report XIII, 1896, pp. 331–341;
Register of Mines and Minerals, San Diego County, 1902.

Also, see Mineral Resources of the U. S.; U. S. Geological Survey. For records prior to 1886, see reports of R. W. Raymond, U. S. Commissioner of Mining Statistics, 1871–1885.

GOLD DISTRICTS.

The principal gold belt, lying in ranges 2, 3, 4 and 5 east, extends southward through a distance of 45 miles, from the Rice or Montezuma district, east of Warner's, to the Mexican boundary. The focus of mineralization appears to have been near Julian and Banner. In the Cuyamaca Grant are several prospects besides the historic and once richly productive Stonewall mine. At Deer Park, Pine Valley and Descanso are a number of gold mining claims, as well as west of the Cuyamaca Grant on Boulder Creek. Nearer the coast, in the vicinity of Escondido, are several prospects and two mines which have been productive. In the south considerable development work has been done near Dulzura and small prospects have been opened near Tecate, Campo and Jacumba. The chief placer in the county is in the Ballena Valley, east of Ramona, and, though not known to have been worked extensively, it is said to have been proven throughout a distance of some 8 miles. Small placers have been worked at many other places, since many gulches have yielded placer gold in the vicinity of gold bearing veins and, also, in areas where no substantial veins have been found.

The districts will be discussed in the following geographic order:

Northern Border.	Julian.	Deer Park.
Montezuma or Rice.	Granite Mountain.	Pine Valley.
Grapevine.	Oriflamme.	Descanso.
Mesa Grande.	Stonewall.	Dulzura.
Escondido.	Boulder Creek.	Mexican Border.
Ballena.		

These districts are all shown on the Economic Map and the individual claims at Julian are shown on the map of that district.

THE NORTHERN BORDER.

Gold has been found in small quantities along the Riverside County boundary at many points. Most of the discoveries are placer deposits and have been chiefly of interest to Indians who have worked, in a small way, in the rainy season. Two of the more important localities are near Fall Brook and near the Temecula or Pechunga Indian Reservation.

MONTEZUMA, OR RICE DISTRICT.

This district, opened about 1896, is about 12 miles north of Banner and 6 miles easterly from Warner's on the slope of San Ysidro Mountain. In the thirteenth report, page 334, it was incorrectly described as east of Banner. The formations are metamorphic, consisting of mica schist, gneiss, quartzite and limestone, and are adjacent to a large granite area. The veins strike north 65° east and dip 70° northwesterly, and are in well-defined fissures, which cut the rocks both in strike and dip. The principal properties are controlled and operated by the Montezuma Gold Mining Company, 506 Timken Bldg., San Diego; H. W. Preston, president and general manager; F. W. Nash, secretary.

Most of the old Rice properties mentioned in R. XIII, pp. 332–345, have been relocated under new names, and several new claims have been added. At present the group comprises: Lost Mine, Granite, Combination, Sunset, Storm, Gold Bar, Virginia, Alta Vista, Eureka, Morning Star, Silver Moon, Red Chief and Bummer. The principal workings and camp are on Eureka and Morning Star.

This company has been carrying on development for about three years and had equipped the property with a mill which was burned in September, 1913. Work has been carried to a depth of 230 feet and aggregates 2,000 feet.

H. Galbraith of Warner's Springs controls the Buckeye group in the same vicinity, consisting of the following claims: Joker, on the Montezuma Vein, Warrior's Mark, Buckeye, Hillside Extension, North Star, East Star, and A. Y. Also the Maid of Erin group, comprising four claims 1, 2, 3 and 4; two on Lost Boy ledge and two on Swastika ledge. Frank Burton of Ramona owns the Swastika claim.

GRAPEVINE DISTRICT.

This camp is about 5 miles southeast of the Rice District and 16 miles from Warner's Springs. The principal property was formerly known as the Dewey Mine, and was opened about 1903. It was equipped with a mill which was never used. At present the chief claim is known as the Ready Relief and controlled by the Colorado Mining and Milling Company—J. A. Heath, San Diego, president, and Fred Wilson, San Diego, secretary. Fred Blethen of Warner's Springs is superintendent. Development work consists of a 100-foot shaft and a

cross cut. A tunnel 975 feet cuts the vein at 200 feet. Two other tunnels are 75 feet and 30 feet, respectively. The vein is stated to be from 4 to 8 feet wide. At present only assessment work is being done.

MESA GRANDE.

This small district was at one time, quite productive, but has been idle for nearly twenty years. It is 65 miles northeast of San Diego and 15 miles northwest of Julian, in the same zone of mica schist. The principal claims are as follows:

Black Eagle. R. XI, p. 382; XII, p. 238. One mile northeast of the Rancheria, 20-foot shaft and some superficial workings. When first discovered the quartz was rich in gold. Owner, Ed. Hinkle, San Diego.

Shenandoah. R. XI, p. 382; XII, p. 242. One and a half miles northeast of the Rancheria. Elevation 3,200 feet. Shaft 175 feet. Steam hoist and 5-stamp mill. Owner, San Diego Business College, San Diego.

Gold Cliff. Has only superficial work.

Red Hill and *Hillside* are other claims long idle. The first is owned by Martin Steenbock and Vance Angel, Mesa Grande.

Wild Cat is a claim owned by Fred Scholder, Mesa Grande.

ESCONDIDO.

In the vicinity of this city, many gold prospects have been opened in the past, and some twenty years ago considerable activity was displayed. But, out of many properties, only two, the Escondido and the Oro Fino, became producing mines and at present all are idle.

It appears that about 1895 there was much prospecting done in this region, and the industry of many prospectors led to the opening of cuts, tunnels and shafts in a score of places. Some eighteen properties were opened but many of them were soon abandoned and some of them are unknown. The Register of Mines and Minerals for San Diego County, issued in 1902, mentions only the Oro Fino; but the Escondido also was probably then in operation. According to the record, thirteenth report, pages 331-347, exploration work in this vicinity was done in five areas, and the claims formerly located may be arranged geographically in the following groups:

I. North, 4 miles. White Oak, La Condado. *Abandoned.*
II. Northeast, 3 to 6 miles. Moe, Monarch, Geneva, Bottle Peak. *Abandoned.*
III. East, 3 to 4 miles. Bloodstone. *Abandoned.*
IV. Southeast, about 2 miles. Escondido, Oro Fino, Cravath. *The only productive area.*
V. Southwest and west in a zone extending from 3 to 9 miles. A number of prospects, showing both gold and copper.

Details of the abandoned claims are to be found in the thirteenth report, pages 331-346. Concerning the others, some additional facts are herewith given.

Group IV. Cleveland-Pacific Mining Co.

Escondido Mine. R. VIII, 524; XI, 382; XII, 240; XIII, 336. Two miles southeast of the city in Lots 2 and 4 of Block 257, and Lot 4 of Block 188. This mine is on the Rincon del Diablo Grant, purchased in 1884, by the Escondido Town and Land Company. From an early period of American occupation it was known as an *antigua,* that is, a property operated by early Spaniards or Mexicans, as evidenced by ancient workings.

About 1868 it was worked by Americans with an arrastre. After several changes in ownership, it was taken up in 1897 by the Cleveland–Pacific Mining Company, which operated for several years, and it has been on record as a producer, Mineral Resources of the U. S.; U. S. Geological Survey, 1907–09; but since 1911 it has been shut down. The corporation is represented by W. F. Speith, manager, 9283 Hough Court, Cleveland, Ohio.

Head Frame. Cleveland-Pacific Mine, Escondido. F.J.H.M. Photo.

The country rock is diorite and the ore is quartz; the vein varying from a few inches to 3 feet in width. Its strike is about north 40° east and the dip about 50° westerly. The deepest workings have a depth of 270 feet. Drifts on the vein amount to about 500 feet.

The equipment consists of two steam hoists and a mill of 5 stamps, with plates for amalgamation, a Wilfley table and two 10-foot cyanide tanks.

Dr. A. S. Eakle determines the wall rock here as granodiorite. A thin section shows much plagioclase, a little orthoclase and quartz, large plates of green hornblende, a few needles or prisms of apatite, and a little magnetite.

Oro Fino. R. XII, 242; XIII, 343. Two miles southeast, Lots 5 and 7 of Block 188.

This mine is about one quarter mile northeast of the preceding, in the same diorite and apparently on a parallel vein lying a little to the west. It has a mill of 5 stamps. It was operated for some years and has been a small producer, but since 1905 it has been idle. Owner, Mrs. O. J. Stough, San Diego. Depth of shaft, 330 feet. Drifts on the vein about 1,000 feet.

Cravath. R. VIII, 524; XI, 382; XII, 239; XIII, 334. Two miles southeast, Lot 2 in Block 321.

This property is about 200 yards northeast of the preceding, and is in the diorite, apparently on the Escondido fissure, the dip and strike of the vein being about the same.

The depth of the shaft is 100 feet. Only a short drift has been carried along the vein. But little work has been done and no production has yet been attained. No mill.

Owned in partnership by H. T. Robertson, $\frac{2}{3}$, and Louis Cassou, $\frac{1}{3}$, both of Escondido.

Group V.

The region west and southwest of Escondido lying between San Dieguito River and San Marcos Creek, throughout a range of hills in which are Mt. Whitney and Cerro de los Pozos, has been extensively prospected and many claims have been located. Most of these have a showing of copper in their outcrop.

Able. Seven miles southwest. R. XIII, p. 331. *Abandoned.*

Clifton. Nine miles southwest. R. XIII, p. 334. *Abandoned.*

Mountain Lion. Six miles southwest. R. XIII, p. 341. *Abandoned.*

Jolly Boy. R. XIII, p. 340. This lies in section 7, township 13 south, range 2 west, together with the claims known as B. S., *Oxide, Mars, Cora B.* and *Sunnyside.* The owners are A. W. Pray, H. H. Case, D. Crise and Cora B. Hall, all of Escondido, who have pooled their interests and hold the claims as a group. But little work has yet been done on them.

Coyote. R. XIII, p. 334. This was a group of four claims, first located in 1896, subsequently abandoned and relocated in 1913, by Peter Schnack of Escondido, under the names *Redrock; R. Extension No. 1; R. Extension No. 2, and R. Extension No. 3.* They lie in section 1, township 13 south, range 3 west, extending diagonally across the section from southeast to northwest. The ore body is in diorite and is said to be about 10 feet wide on the outcrop. It is opened by an incline 225 feet deep.

BALLENA PLACER.

This deposit of auriferous gravel, lying southeast and east of Ramona and first described by H. W. Fairbanks (R. XI, p. 91), is an old river bed with southwesterly trend, belonging to a system of drainage now extinct and possibly of Tertiary age. The gold may have come from the region about Julian. While these gravels have yielded values through a distance of 6 to 8 miles, one of the best areas comprises parts of sections 17, 18, 19, 20 and 21 of T. 13 S., R. 2 E. This ground is now controlled by C. F. Willard, of Ramona. Pay gravel also occurs in the adjoining School Section No. 16. The deposit probably extends south into the San Vicente Grant.

The history and production of this placer are obscure. From the earliest times Mexicans and Indians have worked this ground during the rainy season, when water was available, and there is no doubt that the production has been substantial.

As often happens, some parts of this placer are quite rich and values of $1.50 or more per yard have been reported. While those interested have investigated this deposit with very satisfactory results, there has, however, been no systematic sampling to determine the average value of any substantial area. To accomplish this, it would be necessary to survey the ground, divide it up into squares of convenient size, sink holes or pits at regular intervals and carefully sample the gravel from each opening.

At present such work is not within the scope of the State Mining Bureau, so that little can be said, based on official information. It was long supposed that, as this gravel lay above the present drainage lines, it would be necessary to bring in water from some higher level to wash the gravel. Accordingly a plan was undertaken some years ago to divert some water from the Santa Ysabel Valley and bring it to the Ballena placer through a long ditch. This enterprise was terminated by an injunction obtained by ranchers in the San Pasqual Valley.

Mr. C. F. Willard, who has long been interested in this ground, claims that his investigations establish the fact of an underflow of water in the gravel sufficient to float a dredge.

It seems to be established that a very substantial thickness of gravel exists here, claimed to average 30 feet, with no barren overburden, and it is stated by the owner that values will average 30 cents per yard without reckoning the richer streaks and channels. Undoubtedly in the near future, when industrial conditions improve, this placer will attract the attention of substantial capital and receive the expert examination it deserves.

JULIAN.

This district, which includes Banner, is 55 miles northeast of San Diego, by county highway, and about 35 miles from the railway at Foster.

History.

Gold has been known here since a very early period, and placers were worked in neighboring gulches for some years before the precious metal was found in veins. The first vein discovery is said to have been made late in 1869 on what was afterward the Van Wert claim. On February 22, 1870, another vein was discovered and a claim located on it under the name of Washington. From 1870 to 1880 there was great activity in this district and the production of gold is estimated at over $2,500,000.00.

The conditions in the camp during its Bonanza days, are more a matter of tradition than of history. The State Mining Bureau had not yet been organized and there was no public officer charged with the duty of making a careful record of existing conditions. At that time, however, Dr. R. W. Raymond was acting for the Federal Government as U. S. Commissioner of Mining Statistics, and many details of the discoveries and operations at Julian will be found in his annual reports beginning with the third, dated 1871, and running through the next succeeding volumes. These reports were issued as Executive Documents of Congress, and are to be found in most public libraries. In behalf of the State Mining Bureau, Mr. H. G. Hanks, State Mineralogist, visited Julian in 1886, Mr. W. A. Goodyear reported briefly on it in 1888 and 1889, and Mr. E. B. Preston was there in 1890. In 1892, 1894 and 1896 Mr. W. H. Storms visited the camp and recorded all facts available concerning the properties and their equipment. In 1902 Mr. E. Hubon reported on the details of the properties for the Register of Mines and Minerals. Some statistics of production in this camp will be found in the volumes on Mineral Resources of the United States issued by the U. S. Geological Survey. At the outset of the early operations a substantial zone of secondary enrichment was found, close to the surface, and much rich ore was taken out, some of it having been sold to jewelers for manufacturing purposes. In the course of time these veins were worked down to water level, the free milling ore became exhausted, and, with the appearance of sulphide ores, the values became reduced, and, the metallurgy more difficult, especially as in some mines the ore contains arsenic. Moreover, as the mines grew deeper, those not opened by tunnel were obliged to add, to the cost of mining, the expense of pumping water, for this district has a rainfall of over 30 inches per year.

At present the camp is very quiet, though many owners are keeping up assessment work in hope that financial conditions may change

and that mining properties may again become saleable. Many properties are now inaccessible owing to water in the workings, or to caves, so that little can be seen and little added to what has already been published in the reports of this Bureau, to which the reader is referred for many details which can not now be secured. The principal references are as follows: R. VI, Pt. 1, pp. 85–87; R. VIII, pp. 513–519; R. IX, pp. 143–147; R. X, pp. 541–544; R. XI, pp. 376–381; R. XII, pp. 237–243; R. XIII, pp. 331–347; Register of Mines and Minerals, San Diego County, 1902.

Geology.

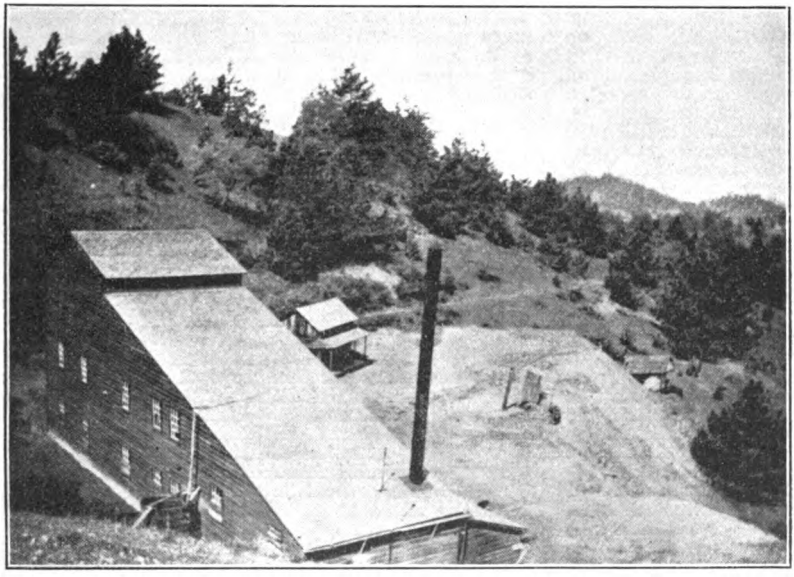
The geology of this district is comparatively simple. The country rock, nearly everywhere, is a metamorphic slate or mica schist, with northwesterly strike and nearly vertical dip, which has been already described and provisionally assigned to the Calaveras group. Here and there, it contains small beds of quartzite which have been used in building house foundations. At some points, it has been injected with granitic matter in thin sheets parallel to the foliation of the schist. When this occurs, a rock results which closely resembles a granite gneiss. Small intrusive areas of granite also appear.

The mineralization of this area is in fissure veins of quartz which, both in dip and strike, are generally parallel to the schistosity of the country rock. These veins are essentially "stringer leads" and are usually small in width, following the curving strike of the schists as they swing westward toward Julian. Several parallel veins have been recognized, four of which have been regarded as continuous for several miles. The easternmost was known as the Chariot vein, those succeeding to the westward being known as the Ready Relief, the Cable and the Ruby, from names of claims located on them. (See map.)

In geologic structure, we have at Julian a miniature "mother lode," and much valuable detail bearing on the geology of the veins there and the conditions under which they were formed will be found in various reports on the Mother Lode and particularly in the Mother Lode Folio of the U. S. Geological Survey.

On account of the extent of this district and in view of the probability that some of the claims will be reopened, it has seemed advisable to give a careful record of the ownership of the properties and their relative positions. Accordingly the following cross-referenced lists have been made of the claims and their owners and a map has been prepared showing the relative positions of the claims now in existence. Careful attention has been given to the preparation of the lists of claims and owners, for many claims have been sold, many have lapsed and been relocated, and a considerable number have

been abandoned and forgotten. The map has been compiled by enlarging the topographical detail of a portion of the Ramona quadrangle of the U. S. Geological Survey, and adding the boundaries of the existing claims as shown on a map of the Julian District, made in 1891 by D. D. Bailey, J. Chamberlain, and W. A. Sickler. The topography is correct, as well as the relative positions of the claims. As to their exact dimensions, there may be some inaccuracies, on account of the many relocations which have occurred, but the map should be of much general value. It is inserted in the margin of the general map of San Diego and Imperial counties.



Shaft House and Dump. Owen's mine, Julian.

List of Mining Claims in Julian District.

Name of property	Map No.	Owner	Address
Aguajita*	125	Smoky City Gold Mining and Milling Company	Pittsburg, Pa.
Alpha*		Mrs. Rosie Jacoby	Los Angeles.
Antelope	93	D. D. Bailey	Julian.
Bedrock	95	Chas. Bacon	Julian.
Belmont	121	D. D. Bailey	Julian.
Blue Jay*	73	John McCain	Julian.
Cable	111	Venturina Mining and Milling Company	San Diego.
California	82	E. F. Bowen	Julian.
Carp	114	D. D. Bailey	Julian.
Chapparal	92	H. A. Landwehr	Los Angeles.
Chariot North	127	F. McN. Hamilton	San Francisco.
Cheerful Moments	99	Oro Blanco Mining Company	San Diego.
Chieftain	71	Martin Jacobs	Julian.
Cincinnati Belle	105	Oro Blanco Mining Company	San Diego.
Contact	101	E. F. Bowen	Julian.
Eagle	75	A. P. Frary	Julian.
El Dorado	91	E. F. Bowen	Julian.
Elevada*	124	Smoky City Gold Mining and Milling Company	Pittsburg, Pa.
Ella	81	E. F. Bowen	Julian.
Empire	102	R. Melrose	Julian.
Fountain	113	D. D. Bailey	Julian.
Fraction	107	Venturina Mining and Milling Company	San Diego.
Friday*†		Friday Copper Mining Company	San Diego.
Gardiner	87	Lincoln University	Lincoln, Neb.
Golden Chariot	128	Chariot Mill and Mining Company	San Francisco.
Golden Gem I	89	D. F. Lane	Julian.
Golden Gem II	88	D. F. Lane	Julian.
Golden Shamrock	93	H. A. Landwehr	Los Angeles.
Gold Drops, formerly Bloomfield	100	E. F. Bowen	Julian.
Gold King*	129	D. C. Collier & Co.	San Diego.
Gold Monster	112	D. D. Bailey	Julian.
Gold Queen*	130	D. C. Collier & Co.	San Julian.
Grand Central	84	L. A. Smith	Julian.
Hassayhampa	86	J. E. McGowan	Julian.
Helvetia*	85	H. A. Landwehr	Los Angeles.
Hidden Treasure	103	D. D. Bailey	Julian.
High Peak	76	H. A. Landwehr	Los Angeles.
High Peak, South	76a	H. A. Landwehr	Los Angeles.
Homestake	109	R. Melrose	Julian.
Howard	119	D. D. Bailey	Julian.
Hubbard North	120	G. W. Hazzard	San Diego.
Hubbard South	122	D. D. Bailey	Julian.
Ivanhoe	78	H. A. Landwehr	Los Angeles.
Janet, Owens W. Extension	68	H. A. Williams	Julian.
Kentuck S.	104	Oro Blanco Mining Company	San Diego.
Madden	98	Chas. Bacon	Julian.
Nip and Tuck	83	E. F. Bowen	Julian.
North Star		Robert Melrose	Julian.
Owens New*	72	H. A. Williams	Julian.
Owens Old*		H. A. Williams	Julian.
Padlock	97	F. Harriett Estate	Julian.
Point Loma	123	Chalmer Bailey	Julian.
Poor Man		Chalmer Bailey	Julian.
Pride of the West*		Rex B. Clark	San Diego.
Raindrop	115	D. D. Bailey	Julian.
Ranchita*	126	C. J. Couts	Vista.
Ready Relief*	117	D. D. Bailey	Julian.

*Patented.
†Copper and nickel.

List of Mining Claims in Julian District—Continued.

Name of property	Map No.	Owner	Address
Redman	110	D. D. Bailey	Julian.
Redman North	108	D. D. Bailey	Julian.
Richmond	90	D. C. Collier & Co.	San Diego.
Roosevelt	70	H. A. Landwehr	Los Angeles.
Rossland	77	H. A. Landwehr	Los Angeles.
Ruby	103	F. Harriett Estate	San Diego.
San Diego	80	H. A. Williams and W. R. Malone	Julian.
Stanley	118	R. Melrose	Julian.
Tom Paine	116	D. D. Bailey	Julian.
Tom Scott	69	Geo. R. Sawday	Witch Creek.
Townsite	79	H. A. Williams	Julian.
Warlock	94b	H. A. Landwehr	Los Angeles.
Warlock No. 2	94a	H. A. Landwehr	Los Angeles.
Warlock No. 3	94	H. A. Landwehr	Los Angeles.
Washington	74	F. Harriett Estate	San Diego.
Van Wert*	67	John McCain	Julian.

*Patented.

List of Julian mining claims arranged by owners. Data of development taken from publications of State Mining Bureau:

CHAS. BACON, Julian.

Bedrock.

Madden. R. VI, Pt. 1, p. 86; XII, p. 242; XIII, p. 341. Two veins, 1 foot. Strike NW. Dip SW. Shaft 200 feet. Tunnel 50 feet. Drifts 500 feet. Depth 125 feet.

CHALMER BAILEY, Julian.

Point Loma.

Poorman.

D. D. BAILEY, Julian.

Antelope. R. XI, p. 380; XII, p. 238; XIII, p. 331. Elevation 3,500 feet; 1 vein, 1½ feet. Strike NW. Dip SW. Tunnel 200 feet. Shaft 100 feet. Drifts 300 feet. Depth 150 feet.

Belmont.

Carp.

Fountain.

Gold Monster.

Hidden Treasure. R. XIII, p. 339; elevation 3,200 feet; 1 vein, 1½ feet. Strike NW. Dip SW. Tunnel 600 feet. Incline 60 feet. Drift 400 feet. Depth 175 feet. Extensive workings above the tunnel level.

Howard.

South Hubbard. R. VI, Pt. 1, p. 87; XI, p. 380; XIII, p. 345. Elevation, 3,000 feet; 1 vein, 12 inches wide. Strike NW. Dip 45° NE. Cross cut tunnel, 300 feet; strikes vein 200 feet below surface. Drifts 90 feet SW., 400 feet NW. A shaft connects adit level with surface. Depth, 275 feet.

Raindrop.

Ready Relief.[1] R. VI, Pt. 1, p. 87; VIII, p. 513; IX, p. 147; X, p. 543; XI, p. 378; XI, p. 378; XIII, p. 344. Elevation, 2,900 feet; 1 vein, 3 feet. Strike NW. Dip NE. This is the northward continuation of the South Hubbard vein. Shaft 200 feet. Incline 100 feet. Tunnel, 2,000 feet. Depth, 250 feet. Worked through 3 adits. Has 10 stamps. Water power mill.

Redman. R. VI, Pt. 1, p. 87; XI, p. 380; XIII, p. 344. Elevation 2,800 feet; 1 vein, 2 feet. Strike NW. Dip SW. North extension of Ready Relief. Vertical shaft 113 feet. Tunnel on vein 120 feet, cutting shaft 25 feet below surface. Total tunnel, 250 feet. Drifts, 300 feet. Depth, 150 feet.

North Redman.

Tom Paine.

[1]Patented.

E. F. BOWEN, Julian.
California. One vein, 6 inches. Strike NW. Dip SW. Shaft, 40 feet. Drifts, 30 feet.
Contact.
Ella. R. VI, Pt. 1, p. 85; XII, p. 239; XIII, p. 335. Elevation, 3,500 feet.
El Dorado. One vein, 6 inches, Strike NW. Dip SW. Open cut, 30 feet. Tunnel, 40 feet. Drift, 150 feet. Depth, 100 feet.
Gold Drops. Formerly Bloomfield.
Nip and Tuck. Formerly Lucky Ben.

CHARIOT MILL AND MINING CO., 555 Mills Bldg., San Francisco. Adelaide Elliot, president; J. H. Isham, secretary.
Golden Chariot.[1] R. VI, Pt. 1, p. 86; IX, p. 147; XIII, p. 337.

R. B. CLARK, San Diego.
Pride of the West. On patented land. Long abandoned as a mine.

D. C. COLLIER & Co., San Diego. C. A. Richardson, president; C. O. Reinhold, secretary.
Gold King.[1] R. VIII, p. 513; IX, p. 43; X, p. 543; XI, p. 381; XII, p. 241; XIII, p. 337. Elevation, 4,000 feet. Shaft with several levels. Mill at Banner.
Gold Queen.[1] R. XIII, p. 337. Elevation, 4,000 feet. Shaft 100 feet on vein in granite.
Richmond.

C. J. COUTS, Vista.
Ranchita.[1] R. XIII, p. 334. Elevation, 3,300 feet. Country rock mica-schist. Strike NW. Dip 70° NE. Parallel irregular quartz lenses cut the strike of the schist at about 20°. These lenses seem to terminate on reaching a fault plane striking east and west. They are from 12 inches to 3 feet wide and are 4 feet to 5 feet apart for some distance along the mineralized zone. Incline shaft 145 feet. Several levels and extensive stopes.

A. P. FRARY, ET AL.
Eagle. R. XIII, p. 335. Elevation, 4,200 feet. Developed by cross cut tunnel. Two veins, 1 foot wide. Strike NW. Shaft, 100 feet.

F. MCN. HAMILTON, San Francisco.
Chariot North.

FRANK HARRIETT ESTATE, San Diego.
Padlock. Two veins, 2 feet wide. Strike NW. Dip SW Tunnel, 50 feet. Drifts, 200 feet. Depth, 100 feet.
Ruby. R. XI, p. 380; XIII, p. 345.
Washington. R. XII, p. 243; XIII, p. 345. Elevation, 4,200 feet. One vein, 1¾ feet wide. Strike NW. Dip SW. Shaft, 135 feet. Tunnel, 100 feet. Drifts, 100 feet.

G. W. HAZZARD, *San Diego.*
North Hubbard. R. VI, Pt. 1, p. 87; XI, p. 380; XII, p. 241; XIII, p. 341. Elevation, 3,100 feet. One vein, 1½ feet. Strike NW. Dip NE. Cross cut tunnel, 580 feet. Drifts, 500 feet. Depth, 250 feet. Winze on superficial workings.

MARTIN JACOBS, Julian.
Chieftain.

MRS. ROSIE JACOBY, 1007 Lake street, Los Angeles.
Alpha.[1] This is stated to be no longer held as a mine.

H. A. LANDWEHR, 507 Union Oil Building, Los Angeles.
Now controls all mining claims formerly included in the Julian Consolidated, High Peak, Warlock and McAllister mining companies. Also the patented land in Sec. 32, T. 12 S., R. 4 E., consisting of the SW. ¼ of NW. ¼, N. ½ of SE. ¼, SW. ¼ of SE. ¼, SE. ¼ of NW. ¼, E. ½ of SW. ¼.

[1]Patented.

The mining claims are in three groups as follows:

(*High Peak Group.* Five claims.)

Roosevelt.

Rossland. Formerly North Star.

High Peak. R. X, p. 542; XII, p. 241; XIII, p. 339. Elevation, 4,400 feet. Two veins, 1½ to 4 feet wide. Strike NW. Dip NE. Shaft, 330 feet. Tunnel, 375 feet. Drift, 1,300 feet.

South High Peak. Formerly Homestake.

Ivanhoe. Formerly Three Brothers.

Helvetia.[1] R. IX, p. 145; X, p. 542; XI, p. 376; XII, p. 241; XIII, p. 339. Vein. Strike NW. Dip NE.

(*Warlock Group.*)

Warlock. R. X, p. 544; XII, p. 243; XIII, p. 345. Elevation, 3,300 feet.

Chapparral. R. XII, p. 239; XIII, p. 334.

Warlock No. 2. Formerly Neptune.

Warlock No. 3. Formerly Hastings.

Golden Shamrock. Formerly Golden Rule.

D. F. LANE, Julian.

Golden Gem No. 1. Formerly Mammoth.

Golden Gem No. 2. Formerly Julian.

LINCOLN UNIVERSITY, Lincoln, Neb. E. J. Swayne, agent, San Diego, Cal.

Gardiner.[1]

J. E. MCGOWAN, Julian.

Hassayhampa. Three veins, ½ foot to 2 feet wide. Strike NW. Dip NE. Tunnel, 265 feet. Winze, 100 feet. Drifts, 100 feet.

ROBERT MELROSE, Julian.

Empire.

Homestake. Formerly Wilcox. R. XII, p. 243; XIII, p. 345. Elevation, 3,100 feet. Two veins, 6 inches to 18 inches wide. Strike NW. Dip SW. Open cut 78 feet. Tunnel, 600 feet. Depth, 150 feet.

Stanley.

North Star. R. XIII, p. 342. Elevation, 3,200 feet; 1½ miles SE. of Banner. Two veins 3 feet wide. Strike NW. Dip NE. On first, shaft 45 feet, drifts 40 feet and 28 feet on the vein. On second vein, shaft 115 feet.

ORO BLANCO MINING CO., San Diego. D. C. Collier, president; C. A. Richardson, acting secretary, Union Building, San Diego.

Cincinnati Belle. R. XI, p. 380; XII, p. 239; XIII, p. 334. Elevation, 2,500 feet. Vertical shaft 230 feet deep. Steam hoist.

Kentuck S. R. X, p. 542; XI, p. 380; XII, p. 241; XIII, p. 340. Elevation, 3,400 feet. Shaft 97 feet, with stopes to the surface, now caved. A new tunnel 70 feet on a 6-inch vein. New shaft 100 feet, cut at 50 feet by adit.

Cheerful Moments. Formerly Sauerbrey.

GEORGE R. SAWDAY, Witch Creek.

Tom Scott. Two veins, 1½ feet wide. Strike NW. Dip NE. Shaft, 225 feet. Tunnel, 300 feet. Drifts, 220 feet. Depth, 225 feet.

L. A. SMITH, Julian.

Grand Central. Vein ½ foot to 3 feet wide. Strike NW. Dip NE. Drifts, 200 feet. Depth, 50 feet.

SMOKY CITY GOLD MINING AND MILLING COMPANY, Pittsburg, Pa.

Aguajita.[1]

Elevada.[1] R. XIII, p. 335. Elevation, 3,300 feet. Opened 1894. Vein Strike NW. Dip 60° SW. Shaft, 160 feet. Levels at 50 feet and 100 feet in vein 2 feet to 8 feet wide. Within this zone are 1, 2 and sometimes three veins carrying gold. At 100 feet a fault has displaced the vein.

[1]Patented.

VENTURINA MINING AND MILLING CO. G. G. Wetherby, president, Los Angeles; Nat. Titus, secretary, 434 Union Building, San Diego.

Cable. R. XIII, pp. 332-333. Elevation, 1,300 feet. Development is on 3 adit levels respectively 217 feet, 160 feet and 330 feet long, the last being the lowest. Considerable stoping was done in the upper levels years ago and the lowest tunnel, which was driven to reach the shoot, encountered 2 separate shoots.

Fraction.

H. A. WILLIAMS, Julian.

Owens.[1] R. VI, Pt. 1, pp. 85-87; VIII, p. 519; IX, p. 144; X, p. 541; XII, p. 242; XIII, p. 343. Elevation, 4,200 feet. Shaft, 350 feet. 1,000 feet of drifts. Four veins, ½ foot to 6 feet wide. Strike NW. 10-stamp mill, steam hoist and Cornish pump. This property consists of 2 patented claims, each 300 feet wide, and designated as Old Owens and New Owens.

Janet. This claim is the west extension of the two Owens.

San Diego. R. XIII, p. 345. Elevation, 4,000 feet. Two veins, 4 feet wide. Incline shaft 70°, 125 feet. Tunnel, 200 feet.

Townsite. Formerly Fourth of July and America.

GRANITE MOUNTAIN.

This is about 10 miles southeasterly from Julian. Gold was discovered here about 1910. A group of seven claims has been located by W. K. Maull, of San Diego, on the slope of Granite Mountain, at an altitude of 4,100 feet. Their position is in township 13 south, range 5 east, near the section corner 15, 16, 21 and 22. The formation is mica schist and the gold values are in quartz veins. One of these is said to be 8 feet wide, another varies from 6 inches to 2 feet. The strike of the main vein is north 50° and the dip southwest. The development work consists of three tunnels, each about 70 feet long with 40 feet of back.

ORIFLAMME.

R. VI, Pt. 1, p. 89. XIII, p. 342.

This mine, 5 miles southwest of the preceding, is about 6 miles southeast of Banner and 4 miles due east of the Stonewall, in T. 14 S., R. 4 E. Sec. 1 and R. 5 E. Sec. 6. It has been idle for many years and very little is known about it. There was a 10-stamp mill in operation in 1886. Transportation is difficult and wood and water are scarce. The ore body is described as in mica schist 3 to 6 feet wide, 1 foot being very rich. The workings amount to 200 feet of tunnels and drifts. In 1902 the owners were J. S. Buck and S. F. Smith, of San Diego.

STONEWALL MINE.

R. VI, Pt. 1, p. 89; R. VIII, p. 515; R. IX, p. 143; R. X, p. 540; R. XI, p. 382; R. XII, p. 243; R. XIII, p. 345. Register, Mines and Minerals, 1902.

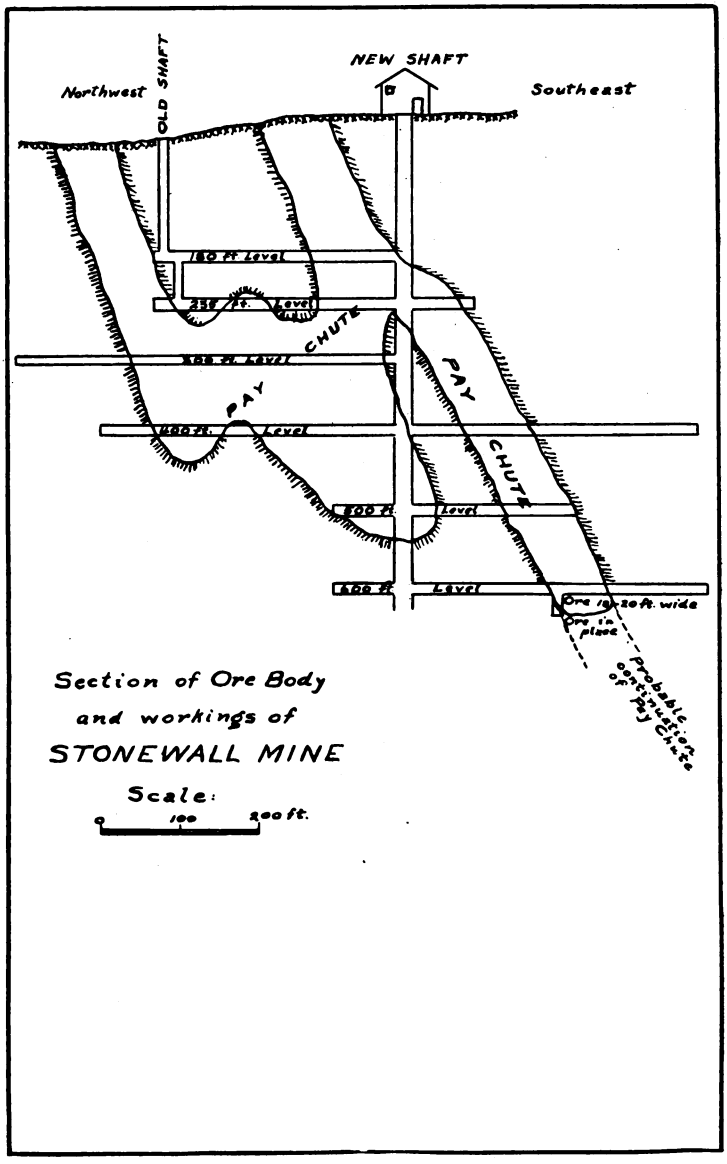
This property is part of the Cuyamaca Grant, owned by the Sather Bank of San Francisco, F. W. Woulfe, trustee. It is situated on the south bank of the Cuyamaca Reservoir.

The country rock is banded mica schist. The vein strikes north 35° west and dips 65° southwest. The mine was located about 1870 and

[1]Patented.

was worked for about five years prior to 1891 by ex-Governor Waterman. A three-compartment shaft was sunk 600 feet and levels driven at 180 feet, 235 feet, 315 feet, 400 feet, 500 feet, 600 feet, north and south on the vein. The total production was about $2,000,000. Between 1888 and 1891 it amounted to $909,442, recorded by the U. S. Mint and the Sather Banking Company of San Francisco.

Through the courtesy of Mr. Frank Robbins, M.E., of Los Angeles, a section of the ore body is here given.



The great production of the bonanza days came from a shoot some 300 feet long which was worked to a depth of 500 feet. Below this level the continuation of this shoot was greatly reduced in size and at the 600-foot level it was worked with a length of 90 feet. Below the 600-foot level a winze was sunk 30 feet, still in ore. The rake of the shoot is to the southeast. At 600 feet the vein is 87 feet from the shaft on the cross cut and the ore body is 160 feet southeast from the shaft on the vein. The ore in places attained a width of 20 feet.

Equipment: Buildings for all purposes; one double reel, hoisting engine 100 horsepower; 1 Ingersoll compressor for 3 drills; 20 stamps; 1 Corliss engine; 5 boilers, 200 horsepower; 1 20-horsepower donkey engine, 1 steam station pump, 2 sinking pumps, 2 water skips, 2 cages, aid drills and other tools.

BOULDER CREEK.

West of the Cuyamaca Grant, on the drainage channel known as Boulder Creek, some claims have been held for several years. There are now 10 of these: Punch Bowl, Little Giant, Condor, Quartzite No. 1, Quartzite No. 2, Apex, Cuyamaca, Golden Eagle, Nebraska and Golden Hill in sections 9 and 10, township 14 south, range 3 east. They are controlled by the Boulder Creek Consolidated Gold Mining and Milling Co., Thomas J. Fisher, President, San Diego; George H. Moyer, Lakeside, vice-president, J. H. Kleine, Lakeside, secretary.

The properties are developed by several hundred feet of tunnels and drifts and are equipped with a 10-ton roller mill and a concentrator.

DEER PARK.

On the east margin of the Cuyamaca Grant, in Sec. 31, T. 14 S., R. 5 E., and near a locality known as Deer Park, about 9 miles northeast of Descanso, are several gold prospects, which have long been known and worked from time to time without becoming producers. The principal of these were noted in R. XIII, page 332, as the Cascade, Combination, Corporal, Hermit, Matamore and Spike and were recorded as the property of John T. Beyers of Descanso. In 1896 they were equipped with a 2-stamp water power mill. In 1902 the Cascade and Independence, both in SE. ¼ of Sec. 31, were reported in the Register of Mines and Minerals, as belonging to Messrs. Saybold and Sunnocks of San Diego. At present these properties, relocated as You Bet, are controlled by Messrs. J. H. Schook of Descanso and J. L. Burns of San Diego. The title to them is in the Cascade Mining Company, Will D. Rudd, president; John L. Burns, secretary-treasurer, 311 Union Building, San Diego.

The present holdings of John T. Beyers are not definitely known, as he has not replied to the letters addressed to him. This region was not visited owing to lack of time and its detailed study has unavoidably been left to a future occasion. Several claims have been reported in

this vicinity, but no definite information could be obtained concerning them. It is probable that some of them have been abandoned. Those definitely located as to position are as follows.

Name	Position	Reported owner	Address	Reference
Free Coinage Double Standard	S. 12, T. 15 S., R. 4 E.	E. Hawkes	San Diego	M. & M.
Hickory Jim	S. 5, T. 15 S., R. 5 E.	J. F. Neeley, Est.	San Diego	R. XIII, p. 339
Lone Jack Expansion	S. 31, T. 14 S., R. 5 E.	John T. Beyers	Descanso	

PINE VALLEY.

This district is on the west slope of the Laguna Range. A number of prospects have been opened in this neighborhood but the principal claims are those known as: THE NOBLE MINES. Report IX, p. 141; X, p. 544; XI, p. 382; XII, p. 238; XIII, p. 342. These are on the west slope of Laguna Mountain, about 9 miles east of Descanso, and the claims are known as Eureka, Treasury, Bay View, Spring, Spring No. 2, South End, Oxide, Mill Site, Telluride. They are in sections 7, 8 and 17, T. 15 S., R. 5 E., S. B. M. Oxide is in the southeast part of the NE. ¼ of Sec. 17; Mill Site in the southeast part of the NW. ¼ of Sec. 17.

Eureka. Tunnel No. 1, 150 feet, 60 feet below surface on lode. Tunnel No. 2, 350 feet, 150 feet below No. 1, partly cross cut, partly on lode. Shaft at mouth of Tunnel No. 1, 100 feet. Drifts at 50-foot and 100-foot levels about 50 feet long. Ground above 50-foot level stoped 300 feet west of shaft. Open cut on lode 200 feet long. All work in mica schist. Strike in vein north 35° west, 125 feet cross-lode shaft on same vein, about 600 feet northwest of shaft mentioned, 50-foot drift at 50-foot level. Open cut 15 feet deep on surface east of shaft.

Bay View. Tunnel 50 feet on vein. Open cut 75 feet long above tunnel. All in schist. This is a continuation of Eureka vein to the northwest.

Treasury. Tunnel No. 1, 300 feet on vein. Air shaft 125 feet, connecting with tunnel. Tunnel No. 2, 75 feet lower 40 feet long. Hanging wall schist. Footwall granite. This vein is parallel to Eureka vein and distant 300 feet. Between Eureka and Treasury are two other veins on which some work has been done. Tunnel No. 3, 200 feet.

Spring. Shaft 200 feet. Drifts on 60-foot level, 80 feet; on 100-foot level, 150 feet; on 200-foot level, 50 feet. All in schist. Shaft house 20 by 40. Twenty-five horsepower gasoline hoisting engine, blower and pump.

South End. Tunnel 25 feet. Crosscut. Eureka and Treasury veins run through this claim.

Oxide. In schist. Tunnel 250 feet on vein. Air shaft 50 feet. Winze 150 feet, on 100-foot level drift 150 feet. Thirteen horsepower

gasoline hoist in tunnel. This claim lies on the east side of the schist belt which is about 1 mile wide.

Telluride. Only surface work and 25-foot tunnel on quartzite. This claim is contiguous to the Mill Site on the east. These veins are in the schist belt which continues southeast several miles.

Mill Site. Crosscut tunnel 40 feet. Shaft 25 feet in quartzite which carries values. The mill is on this claim and also the living quarters. The former consisting of grizzly, ore-bin, Blake rock breaker, self-feed. Five stamp mill, 650-pound stamps, discharging into one 7-foot Lane slow-speed mill, which discharges over 10-foot plates upon two 6-foot Frue vanners. From four to eight months of the year, the mill is run by water power generated by a Knight 40-inch water wheel under 200-foot head. For the dry season there is a 22 horsepower Foos gasoline engine to furnish power. The equipment also includes 10-kilowatt dynamo for lighting mill and house; blacksmith shop with tools; 3,500 lineal feet flumes, 14″x11″; 700 feet 8 inch pipe connecting flume with wheel. Assaying outfit. Five houses and barn.

DESCANSO.

Gold occurs at 300 yards west of this village where Dr. A. J. McDougall controls a number of claims including the Magdalena. The veins trend east and west in diorite. Development work has been carried to the extent of a 100-foot shaft.

A number of claims and prospects are reached from this place, concerning which little information could be obtained. Among them are the following:

Name	Location	Owner	Address	Reference
Clark Mine	9 miles NE. of Descanso	Clark	Descanso	R. XIII, p. 334.
Happy Jack, Iron Mask, War Eagle	7 miles NE. of Descanso	G. Collier Robbins, deceased		R. XIII, p. 339.
Harper's Mine	12 miles NE. of Descanso. This is within the Cuyamaca Grant	J. D. Harper		R. XIII, p. 339.
Culver, El Toro	Quayle Bros. & Cressy		San Diego.	

DULZURA.

R. XI, p. 382; XIII, pp. 335 and 340.

In this district the ore deposits are chiefly in mineralized zones in quartzite and gneiss. The main zone of mineralization is quite extensive, being covered by locations for a distance of 3 miles. It begins in Sec. 8, T. 18 S., R. 2 E., and crosses Sec. 16 diagonally from its northwest corner, bearing about south 39° 30′ east. At some points, in a width of 300 feet there are two or three parallel zones of mineralization. West of the granite, quartzite adjoins a formation of partially metamor-

phosed black slate and schist. In this, not far from the auriferous zone, is a lens of jasper, which may indicate an equivalence of this slate to the Jurassic, San Luis formation.[1] It may, however, prove to be the Julian formation.

The most extensive holdings are those of Stuart Donohue, comprising the following claims: In Sec. 8, Defiance and New Deal; North Star within Sec. 16, and in Sec. 21 Gold Chief of the Hills, and Golden Artery to the southeast of the preceding. The last two are patented. Beyond them in Sec. 22, along the same mineral zone, are Imperial and Owl.

In Sec. 16, which is School land, are the Johnston and Oneida properties, controlled by Elliott Johnston and others of San Diego. In Sec. 22, east of the Donohue claims and nearly parallel to them are the Pasadena and Banco de Oro claims, controlled by John Fogarty and Charles Burroughs, 553 Fifth street, San Diego.

The owners have been prospecting and developing their claims for some twenty years, but, while much work has been done, no large bodies of rich ore have been found and no substantial production has been attained. The Donohue properties are equipped with a 2-stamp mill.

It seems as if this mineral zone deserves careful study to determine its availability for operation, on a large scale, as a low grade proposition.

Barber Mountain, 4 miles northeast of Dulzura is in Sec. 12, T. 17 S., R. 2 E. There is a property on the southeast side of this mountain, formerly controlled by the Barber Mountain Mining and Milling Company, and now called the Gold Star claim.

The owners are William Hooper and W. E. Kitzman of 846 Fifth street, San Diego. The ore is auriferous chalcopyrite, which occurs in stringers. Development has been conducted by a tunnel 80 to 100 feet long.

MEXICAN BORDER DEPOSITS.

Gold is found at many points near the Mexican boundary, on both sides of the line and in placers as well as in veins. From the placers considerable gold has been taken by hand labor, but none of the veins have yet become producers in a substantial way, though quartz specimens of high grade are often brought in by prospectors.

Near Tecate, Campo and Jacumba, occurrences of this nature have been reported many times during a number of years.

COPPER.

Copper minerals, in limited quantity, are found at several points within this county. One locality called the Defiance District is in the extreme northwestern corner of the county, near the San Mateo Canyon

[1]See San Luis Folio, U. S. Geol. Survey.

and just north of the Santa Margarita Ranch. It is reached by wagon road from Murietta, Riverside County.

All of the claims in this district, mentioned in the Register of Mines and Minerals of San Diego County, have been abandoned. F. McIntosh, of Coronado, was the chief operator.*

This metal has also been found at several points in the hills between Escondido and Encinitas. Some of the claims near Escondido are being kept alive by assessment work, but the old Encinitas Copper mine has not been worked for several years.

This mine is in Sec. 28, T. 13 S., R. 3 W. and is controlled by the Encinitas Copper Company, of which the present representative is W. C. Harland, Spreckels' Theater Building, San Diego. This mine is described in Bull. 50, pages 344–45. There were twenty claims and the vein is 3 feet wide, in porphyry and carries chalcopyrite. There are two shafts and two tunnels on the property. It was proposed to concentrate the ore to prepare it for shipment.

Southwest of Julian the Friday mine, long owned by James Stratton of Julian, is characterized by a considerable extent of iron cap or gossan and shows in its workings copper sulphides and carbonates with small amounts of nickel. This is being developed on a moderate scale. The property which is patented, consists of the north 20 rods of the east 56 rods, SW. ¼ of SW. ¼, Sec. 15, T. 13 S., R. 4 E., and is controlled by the Friday Copper Mining Company, Frank H. Brown, president, American National Bank Building, San Diego; Beecher Stern, secretary, West Coast Gas Engine Company, H and Union streets, San Diego.

The ore body has been opened by a vertical shaft, which is in ore for 60 feet. Below this the vein dips away from the shaft and has been cut by levels at 100 and 130 feet. The upper 60 feet is in the zone of oxidation. At 100 and 130 feet the ore consists of copper sulphides carrying nickel up to 22 per cent.

Assays, Friday Copper Mining Co.

By C. E. Anthony, San Diego, Cal., September 15, 1913.

Gold	.16 ozs. per ton
Silver	1.3 ozs. per ton
Copper	2.4 %
Silica	25.20%
Aluminum and iron	40.24%
Sulphur	5.50%
Arsenic	2.28%
Nickel	22.98%

By C. E. Anthony, San Diego, Cal., December 10, 1913.

Nickel	9.12%

By C. E. Anthony, San Diego, Cal., December 12, 1913.

Nickel	7.78%

*Since this report was written, W. A. Clark, of Fallbrook, has taken up some claims in the San Mateo Canyon.

By C. A. McAuliffe, Los Angeles, Cal., December 23, 1913.

Nickel	10% (12.8% NIO)
Iron	26% (37.4% FEO)
Gold	$4.90
Copper	Trace
Silver	None
Lead	None

A number of other claims have been located on outcrops near the Friday. Some of these are shown on the Julian map. One of them, the Copper Brick, is owned by Robert Melrose of Julian.

On the San Vicente Grant is a small deposit known as the Barona mine (*see* Bull. 50, p. 345), belonging to L. T. Daley, 1111 C street, San Diego. The vein is in granite and has been explored to a depth of 45 feet. The ore, consisting of copper sulphides and carbonates, carries gold and silver. Chalcopyrite, carrying gold, has been found in small quantities on the east slope of Barber Mountain east of Dulzura. See Gold Star claim under Gold.

From the surface indications, it seems improbable that any one of the deposits, thus far known, has sufficient magnitude to develop into a copper mine of much importance, though some may yield limited quantities of shipping ore.

SILVER.

This precious metal is commercially unknown in San Diego County for the argentiferous lead ores thus far discovered are wholly insignificant. Silver is said to occur in the copper ore at the Barona mine and in that of the Friday mine, near Julian. Further than this silver occurs in small quantities, alloyed with gold, wherever the latter occurs.

In addition to the silver lead ore at Valley Center, a small deposit has been reported from the vicinity of the Noble mines. A. Miller of Descanso at one time worked a claim there.

LEAD.

This metal has been reported in small quantities at several points, the chief occurrence being about 2½ miles north of Valley Center, in the NW. ¼ of Sec. 1, T. 11 S., R. 2 W. Here a formation of mica schist crosses the section obliquely toward the northwest. This schist is quartzose in places and is succeeded on the east by feldspathic quartzite 200 feet thick. Near the north line of the section, in the mica schist, a small outcrop was found, several years ago, containing zinc blende and galena, which, on assay, proved to contain silver. So far as it has been opened, this ore body is small, the vein which dips 60° southwest being about 3 feet wide.

The property is called the Surprise. The chief owner is W. N. Bradbury, who acts as trustee in conjunction with W. H. Baldridge

and C. M. Churchill, all of Escondido. The property includes two claims and 80 acres of patented land. The workings consist of a 45-foot shaft and a tunnel 110 feet long with 60 feet of back. Some further exploration was being made at the time of the writer's visit. Lead has also been reported from a point called Metal Mountain on the east side of the Laguna Range and from the vicinity of Deer Park.

ZINC.

This metal is of very sparing occurrence in San Diego County. Besides the Valley Center locality described above, it has been reported from the hills of the San Vicente Grant.

IRON.

R. IX, p. 144.

A few deposits of ferriferous material have been reported in this county but they seem for the most part to be the oxidized capping of veins which, through the oxidation of sulphide ores, have left a formation of gossan at the surface.

The outcrop in Sec. 15, south of Julian is the gossan of the Friday vein, which carries copper and nickel. The 12 to 15-foot vein reported by Goodyear, at corner of Secs. 34 and 35, T. 13 S., R. 2 E. and Secs. 2 and 3, T. 14 S., R. 2 E. and belonging to A. Juch, of Wynola, is said to be of the same character. It is needless to state that such exposures do not represent sufficient tonnage to be of importance as sources of iron ore. They might, however, prove valuable for mineral paint.

MANGANESE.

This metal is nowhere in the county known in commercial quantity. A mile and a half northwest of Jacumba are surface indications of manganese in the form of superficial deposits of the oxide. Some of these may come into use for mineral paint. It has also been reported from the vicinity of Campo.

MOLYBDENUM.

With the advance of civilization, this metal is becoming of increased importance. For a long time its chief use was in the manufacture of ammonium molybdate employed as a chemical reagent in the determination of phosphorus and therefore much used in iron and steel analysis. Sodium molybdate is a blue pigment used in coloring pottery and porcelain, including artificial teeth. Lately it is frequently used with iron in steel alloys for tool steel and for magnets, up to 6 per cent being employed. It is also used in supports for the lower ends of tungsten filaments in electric lamps, and to some extent in electric furnaces.

Ores of this metal have been found at several points in this county. They are reported from the international boundary southeast of Campo and at several points between Campo and Julian. The chief deposit thus far discovered is about 11 miles from Foster and 7 miles northwest of Ramona, on the south edge of the San Pasqual Valley. The ore is chiefly molybdenite, the molybdenum sulphide containing 60 per cent molybdenum, with a small amount of molybdite or molybdenum oxide. It occurs disseminated in flakes and small masses in a micaless granite or aplite which appears to be a dike in the surrounding biotite granite. The prospect work has opened the rock at several points and the molybdenum minerals occur in a zone 30 feet or more in width. Samples of the granite have proved, on assay, to contain 2 to 2½ per cent molybdenum sulphide. Dr. A. S. Eakle determines the dike rock carrying the molybdenite to be a quartz-feldspar mixture without magnesian silicates. A thin section shows orthoclase and quartz predominating, a small amount of albite, microcline and magnetite.

This property belongs to Mrs. E. M. Bour, 918 Harrison ave., San Diego, but is controlled by the Santa Maria Molybdenum Mining and Milling Company, president, E. W. Bour; secretary, E. A. Wagener, 1254 First street, San Diego. Lying in the SW. ¼ of Sec. 3, T. 13 S., R. 1 W., which is covered by agricultural patent, the dike trends southeast, passing into Sec. 10.

TIN.

Some years ago, before Riverside County was formed, San Diego County included the tin mines of Cajalco, but at present no deposit of tin ore is known within its limits that can be regarded as of commercial importance.

Placer miners, working in the mountain gulches, have brought in, from time to time, specimens of black sand containing small grains of Cassiterite or oxide of tin. The principal localities are the gulches on the east slope of the Laguna Mountain. It is also reported from some of the placers in Pine Valley and from the south end of Viejas Mountain east of Alpine, but the latter report lacks confirmation. Another reported discovery is in the Defiance copper district north of the Santa Margarita Grant.

This metal is chiefly used in making tin plate, but also for tin foil and in various alloys such as babbitt, solder, electrotype metal, bronze, etc. The chlorides of tin are used in the silk industry and in dyeing and calico printing.

NICKEL.

This metal, up to 23 per cent, was found by assay in ore from the Friday mine near Julian, which had long been known as a copper prospect.* A small sample shown to the writer had the appearance of Niccolite, a nickel arsenide. No substantial ore body has yet been developed but exploration is now in progress. The association of copper with the nickel involves the use of wet processes in its metallurgy. The chief use of nickel is in making nickel steel which is very tough and resistant to shock. A compound of nickel and iron called invar is used for steel tapes and watch springs, since it varies but little with change of temperature. A very large amount of nickel is used in nickel plating. The metal is also used as a reagent or catalyzer in hydrogenating oil.

Since this area was visited the nickel discovered has attracted much attention. Many new claims have been located and development has been started at several points. A recent discovery of this metal is on the old Gilson property, on the line between the SW. ¼ of Sec. 15 and the SE. ¼ of Sec. 16, T. 13 S., R. 4 E. Rumor mentions an ore body 15 feet wide, averaging 8 per cent nickel at 130 feet depth.

ANTIMONY.

This metal, probably in the form of the sulphide, stibnite, has been reported from several points about the Laguna Mountain, but no definite locality has been announced and the quantity discovered is probably small. Stibnite has also been reported from a point 4 miles west of Jacumba. Antimony is chiefly used in hardening alloys. Its property of expanding in cooling after fusion makes it invaluable in alloys for type metal as it receives sharp edges from the matrix.

BISMUTH.

This metal has been found in small quantities, associated with amblygonite in the lithia vein at Pala. It occurs both as native bismuth and as an oxide. Small samples of native bismuth have been reported from other points, especially near Jacumba. Its uses are in fusible alloys for electric fuses, for protecting boilers, etc., in painting on glass and porcelain and in medicine.

TUNGSTEN.

Trivial specimens of the ores of this metal are said to have been found from time to time, and in the State Museum at San Francisco is a specimen marked Julian, A. J. Burnett; but no deposit has yet been observed which promises to be of any commercial importance. Tungsten is chiefly used in making high grade tool steel, either alone

*See Friday mine, under Copper, for assays showing nickel.

or alloyed with molybdenum and chromium. Its steel alloys have great toughness, and they are used for armor plate and projectiles. It is also used in place of platinum for crucibles and electric furnaces. In the form of fine wire it is extensively used for filaments in incandescent lamps. Sodium tungstate is used as a mordant in dyeing, for weighting silks and for making cloth inflammable.

NON-METALLIC MINERALS.

BUILDING STONE.

With the rapid growth of San Diego as a city and the increasing demand for materials of construction, the use of building stone has rapidly increased and several quarries have been opened in the granites which are so abundant and so easily accessible to transportation. Economy in building, however, is an important factor and the cheaper materials, brick and reinforced concrete, are so generally in use that the more costly granite is chiefly used for monumental and decorative purposes.

No sandstones have been found in the county suitable for building. Near Valley Center is a quartzite which may be fit for quarrying. A few localities of marble are known but have not yet been developed. These are discussed under the proper head.

GRANITE.

Bulletin 38, pages 52-3.

Granite occurs in this county in great variety and abundance, and in excess of all possible future demands. The determining factors in selecting a location for a quarry are first, quality of material and second, convenience for transportation. The larger granite areas throughout California are, consequently, seldom of commercial interest because through altitude or otherwise, they are usually remote from lines of transportation. The quarries of granite opened in San Diego County, as well as those of the other building stones, are, therefore, easy of access.

The following companies and persons are now operating:

Simpson-Pirnie Granite Company, James Simpson, president, Peter C. Pirnie, secretary. Office and works. Two quarries are worked. One is near Santee station on the San Diego, Cuyamaca and Eastern Railway, 25 miles from San Diego in the east side of the hill south of the station. The property comprises 49 acres.

The granite is quarried by hand. The stone is a bright-colored, light gray grano-diorite with a reddish to brownish tint on the weathered outcrop. In some places this discoloration from the oxidation of the iron extends several feet below the surface, while in others it is merely superficial. For the most part the rock is massive and almost

free from open seams. It has a remarkably straight fracture, and is easily obtained in rectangular blocks as large as can be handled. There is little stripping and no expensive waste in quarrying. The stone is quite uniform in texture and color, with the exception of a few small blotches caused by local segregation of dark mica flakes. It is largely used for monuments, and for this purpose is cut and dressed at the company's yard in San Diego and shipped in considerable quantities to Los Angeles and other points in southern California. It also makes an excellent building stone, for which it is used to some extent. The annual product amounts to 5,000 cubic feet of dimension stone, 200,000 of paving blocks and 1,500 tons of riprap.

A second quarry of light gray fine-grained granite, controlled by this company, is about 1½ miles west of Foster, in the E. ½ of SE. ¼, Sec. 35, T. 14 S., R. 1 W. The product is used for monuments and paving blocks, the annual output being about 3,000 cubic feet of dimension stone and 100,000 paving blocks.

Andrew Lehnberg, of Foster, operates a quarry on El Cajon Grant, west of Foster, and about 600 yards south of the Simpson-Pirnie quarry. This is also a biotite granite. He also operates a quarry of dark green rock near Lakeside, which Dr. A. S. Eakle has identified as a diorite. This material is derived from boulders, no ledge having yet been opened.

The old Waterman quarry lies 1¼ miles northeast of Foster, near the road to Ramona, in E. ½ of SW. ¼ of Sec. 30, T. 14 S., R. 1 E. It is now owned by Mrs. Emma Cartwright, of Foster, and worked by James and John Grant, of the same place. The rock is a biotite granite, and was used for the Government buildings at Fort Rosecrans.

The old quarry east of the station, owned by Joseph Foster, of Foster and San Diego, is now idle. Until recently, it was leased by the Pacific Electric Railroad Company which quarried paving blocks there.

Charles G. Moore, 2336 Superba street, San Diego. This quarry, which has been in operation about five years, is east of La Mesa, in the east 370 feet of the S. ½ of the SE. ¼ of the SW. ¼ of the SE. ¼ of Sec. 17, T. 16 S., R. 1 W. This stone, which is a diorite, is wholly used for monumental purposes and about 8 carloads of 200 cubic feet are consumed annually.

San Diego Granite Works, corner Eleventh and M streets, San Diego, Fred Fickas, proprietor. Formerly operated a quarry near Mt. Helix, one quarter mile east of Hotel Grossmont. Also at one time operated the quarry near La Mesa, now controlled by Charles G. Moore. It now uses stone from the Simpson-Pirnie quarry west of Foster and from Lehnberg's quarry near Lakeside.

South of Grossmont station is a small quarry on land owned by E. Fletcher, of San Diego, and operated by the Pacific Electric Railway Company for paving blocks. The rock is a hornblende, biotite granite and cleaves into rectangular blocks of great regularity.

Dr. A. S. Eakle's determination of these rocks is as follows:

Pirnie-Simpson, Santee. Granodiorite. A thin section shows much triclinic feldspar as well as orthoclase, a small amount of quartz, biotite and hornblende.

Pirnie-Simpson, Foster. Light gray fine grained granite. A thin section shows much hornblende and orthoclase, little biotite and plagioclase. Some magnetite. The orthoclase is somewhat kaolinized.

Lehnberg, Foster. Biotite-granite. Light gray granite. A thin section shows much quartz and orthoclase, a small amount of plagioclase and brown biotite. Grains of magnetite occur.

Lehnberg, Lakeside. Hornblende-diorite. A thin section shows plagioclase predominating and scattered plates of hornblende. A few rods of biotite occur. The rock has a sprinkling of magnetite with an occasional grain of pyrite.

Waterman, Foster. Granite. A thin section shows quartz, orthoclase, a little plagioclase, some biotite in stringers, very small hornblende, chlorite and magnetite. The orthoclase is slightly kaolinized.

Moore, La Mesa. Diorite. A thin section shows plagioclase predominating, a little orthoclase, biotite and hornblende in about equal amounts, some apatite needles and magnetite grains. An occasional augite crystal occurs.

Pacific Electric Railway Company. Grossmont. Light gray hornblende-biotite-granite. A thin section shows much plagioclase and orthoclase, large plates of biotite and hornblende and some magnetite.

LIMESTONE AND MARBLE.

Limestone, which mainly consists of carbonate of lime, is used for building and ornamental purposes, but chiefly in the metamorphic or crystalline form, which is known as marble.

In San Diego County crystalline limestone occurs at many points, in the areas of metamorphic rocks, but owing to lack of transportation in the regions where it occurs, little attention has hitherto been given to this material.

Near Deer Park, in Sec. 1, T. 15 S., R. 4 E., are two claims, located on white marble, known as North Glacier and South Glacier, controlled by C. P. Hayes, Wm. A. Berkey and Zoe Beyers Vernon. This interest is represented by G. T. Vernon, 523 Timken Building, San Diego, and J. G. Beyers, of Descanso. It is at present intended to undertake the manufacture of lime, bringing the product to San Diego by motor truck.

About 4½ miles northwest of Borrego Springs, Secs. 2 and 3, T. 11 S.,

R. 7 E., is an outcrop of limestone on which claims have been located by Dr. D. B. Northrup, 771 Twenty-second street, San Diego, and T. A. Eckert.

Very extensive deposits of marble, of several shades of color, which will soon be made accessible by the San Diego and Arizona Railroad, are in Coyote Mountain, T. 15 S., R. 10 E., a few miles east of the San Diego County line. These will be described under Imperial County.

About 4½ miles northeast of Dos Cabezas Springs, Sec. 21, T. 16 S., R. 8 E., are two claims covering a deposit containing two colors of marble, and belonging to the Golden State Mining and Marble Company, C. A. Walker, president, Watts Building, San Diego. One stratum, extending about 600 feet in length and 20 feet in width, is pure white, interspersed with tiny black dots. This marble is of high grade, fine grained, slightly harder than common marble and takes a high polish. Adjoining this stratum is one of light gray blue over 600 feet in length and about 180 feet in width. This is of the same quality as the white and black dotted, and is well suited for interior decoration, as in corridors and panels. This deposit lies about 1 mile from the San Diego and Arizona Railroad, but must await the completion of that line.

Near Jacumba, Sec. 2, T. 18 S., R. 8 E., is a dark gray marble on which some claims were located by Mr. L. A. Blockman, of San Diego.

MEXICAN ONYX OR ONYX MARBLE.

This handsome ornamental stone is mineralogically aragonite, a form of carbonate of lime often deposited from hot springs. The only occurrence in this county has been reported from the valley of Los Peñasquitos Creek on the grant of that name.* The exact locality could not be ascertained by the writer.

JASPER.

A deposit of red and white banded jasper occurs southeast of Dulzura, east of the Donahue gold mining claims. Dr. C. C. Vallé, of San Diego, is the owner of the property. This material is handsome and may become valuable for ornamental purposes, but it has not yet been offered on the market.

ORBICULAR GABBRO.

Bull. 38, p. 56.

About 6 miles east of El Cajon on the north bank of the Sweetwater River, and about 1 mile west of Dehesa, in Section 14, T. 16 S., R. 1 E., is a large mass of gabbro, portions of which have an orbicular structure and show a highly ornamental surface when polished.

This gabbro is intrusive in the midst of the granite. It outcrops over an area of about a square mile on the hill near Dehesa and extends 3 or

*Bulletin 38, page 369.

4 miles southeast. The hill on which it occurs rises about 1,800 feet above sea level. On the slopes, in the central portion of the gabbro mass, the orbicular rock occurs in scattered boulders, which vary in size, some of the larger ones being several feet in diameter. It has not, however, been found in place.

There are three varieties of this orbicular rock, based on variations in its texture. In the most common variety, an outer ring of feldspar surrounds a nucleus consisting of a crystalline aggregate, much like the ground mass of the rock. Another variety consists of spheroidal bodies showing neither concentric nor radial structure. These appear to be harder and of firmer texture than the surrounding material and, on the disintegration of the rock by weathering, rounded balls remain like pebbles in the residuum. The third variety has both radial and concentric structure.

The rock consists of the plagioclase feldspar, anorthite, hornblende, hypersthene and iron oxide. It varies considerably in texture outside of the spheroids, some portions of the mass being rather finely crystalline and others quite coarsely crystalline. Some of the hornblende crystals, in place along joint planes, are several inches in length. The basic character of the orbicular portions is shown by the analysis of an orbule.

Analysis of an Orbule of the Gabbro by Jas. W. Howson.[1]

	I	II
Silica (SiO_2)	40.50	39.76
Alumina (Al_2O_3)	23.01	22.71
Iron oxide (FeO)	11.96	11.96
Magnesia (MgO)	12.24	12.56
Lime (CaO)	11.44	11.39
Soda (Na_2O)	1.19	1.33
Potash (K_2O)	.40	.37

Analysis of the Feldspar of the Gabbro by W. T. Schaller.[2]

Silica (SiO_2)	----------	44.39
Alumina (Al_2O_3)	----------	36.55
Lime (CaO)	18.67	----------
Soda (Na_2O)	.83	----------

This analysis indicates anorthite or lime feldspar.

This orbicular gabbro is adapted to interior decoration, because of its variegated texture and color. Without being gaudy or bizarre, it has a rich coloring and a unique configuration that should catch and please the eye.

No definite estimate can be made of the quantity of this stone now available. It is seen only in boulders, and these form but a small per-

[1] Univ. of Cal. Dept. of Geol. Bull. No. 17, Vol. III, p. 394.
[2] Bull. 38, p. 59.

centage of the boulders on the hillside. Their occurrence is such as to leave one in doubt as to whether they came from a single dike-like portion of the mass, or from several separated portions. The number and size of the boulders scattered over the surface indicate that there is considerable stone here available for commercial purposes, and exploration may reveal the rock in place. If it should be found in sufficient quantity to furnish a constant supply to the market, and to fill orders in a reasonable time, it ought to readily find a place among ornamental stones. Since it is almost unknown as a commercial product, architects would be slow to specify it until assured that it is obtainable in quantity.

This gabbro area was first mentioned by Fairbanks, R. XI, p. 85. The orbicular rock was first discovered by Marion Powers , of Dehesa. Professor A. C. Lawson, of the University of California, gave a short description of it in "Science," Vol. XV, page 415, and a more extended one in Bull. No. 17, Vol. III, Dept. of Geol., Univ. of Cal. W. H. Kessler and W. R. Hamilton, of Stanford University, made a study of this rock and published an excellent illustrated description of it in the American Geologist for September, 1904. See Bull. Nos. 37 and 38, State Mining Bureau.

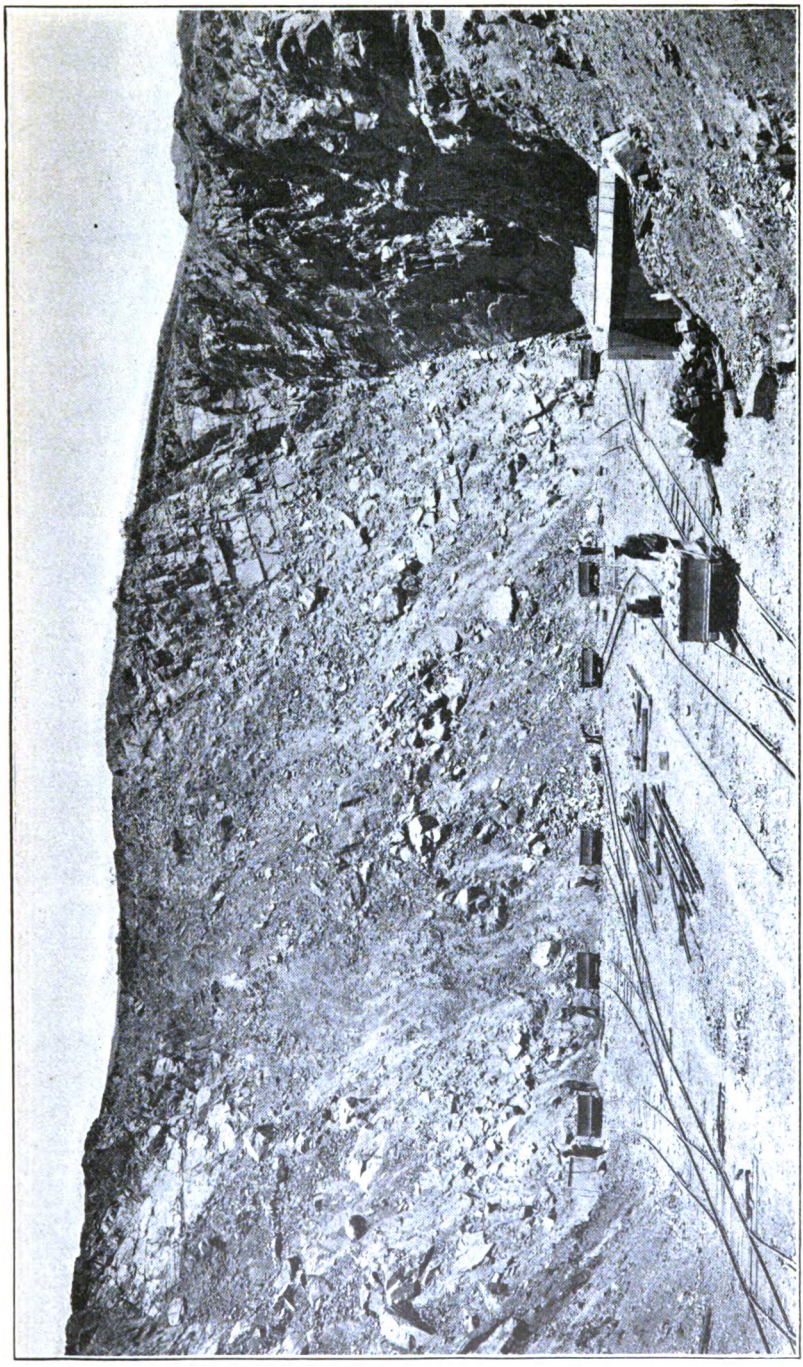
The deposit is controlled by N. Kessler and Marion Powers, of Dehesa.

CRUSHED STONE AND SAND.

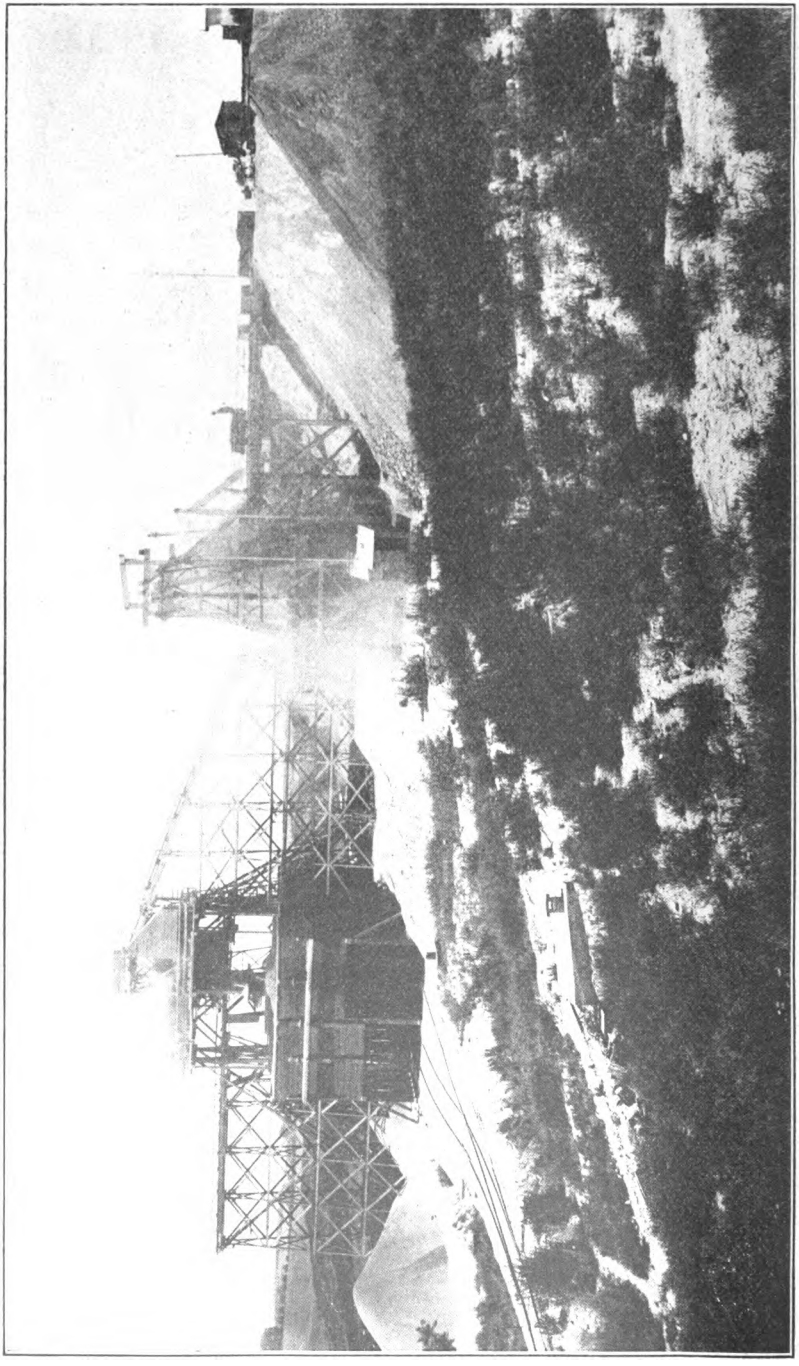
The large demand for crushed stone and sand for concrete and their ever-increasing consumption make these materials of great importance to a municipality.

San Diego is especially favored in the extensive area of intrusive felsite which is now quarried at Spring Valley and Sweetwater Dam, and, if necessary, could be quarried at other points. The gravel from the Otay River Valley and from Rose Canyon as well as from other areas around the Mesa is almost entirely of felsite or some other volcanic rock of similar qualities.

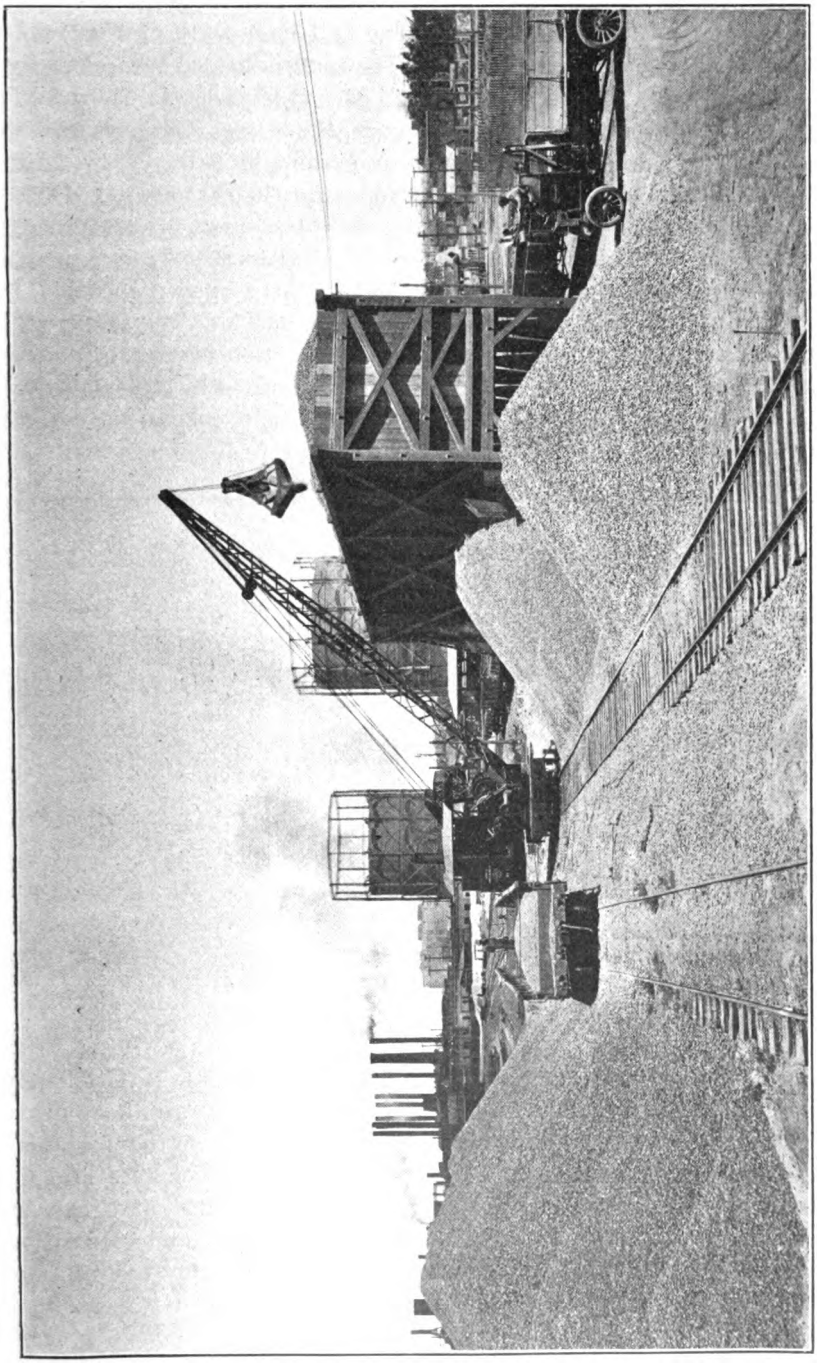
Independent Stone Company, 713 American National Bank Building, Geo. L. Parker, president, L. J. Rice, secretary. This company produces crushed stone for concrete and sand for the same purpose and for general building operations. The stone quarry is southwest of Spring Valley station on the west side of the track. The crushing plant is on the east side of the railroad at the same point. The rock is a fine grained felsite which forms a hill immediately north of Lemon Grove, rising some 300 feet above the mesa level. The production of crushed stone is 75,000 tons per day.



Quarry of the Independent Stone Co. Near Spring Valley.



Crushing Plant of the Independent Stone Co. Near Spring Valley.



Filling Storage Bins. Independent Stone Co.

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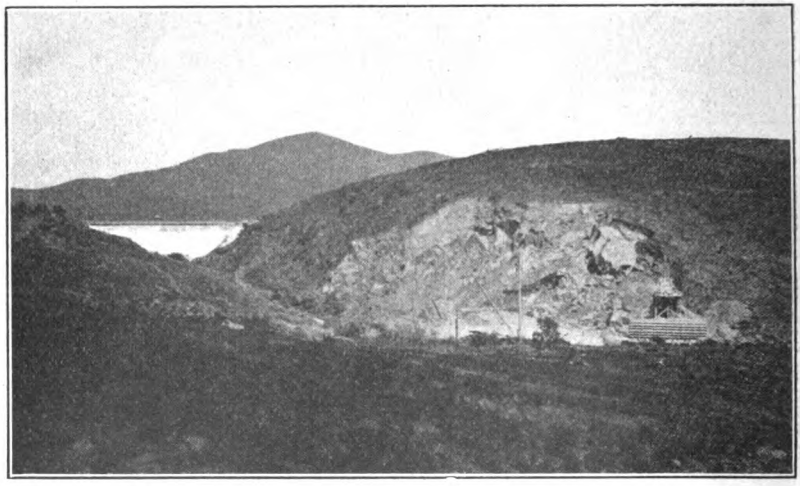
Building sand washed from the neighboring granite areas is shipped by this company from the river bed one half mile south of Foster and 300 feet west of the railroad track. The sand is loaded into cars by a Brown hoist of 15 tons capacity, using a 5½-foot bucket. At the delivery station, at Thirteenth and Newton streets, San Diego, the cars are unloaded and the sand transferred to storage bins by a Bay City Industrial Crane, using a 1-yard bucket. Production 40,000 tons per day.

San Diego Stone Company, 643 Spreckels Building. President and manager, E. A. Hornbeck; secretary, C. Kalbough. This company produces crushed stone for concrete. The quarry opened in 1887 for Sweetwater Dam, is west of the dam on the south side of valley. The property consists of 15 acres held in fee, a portion of the Rancho La Nacion. Gates and Simons Disc crushers are operated by electric power. Daily capacity of plant 400 tons. The annual production of crushed stone is about 49,000 tons. Of riprap and jetty stone 21,000 tons.

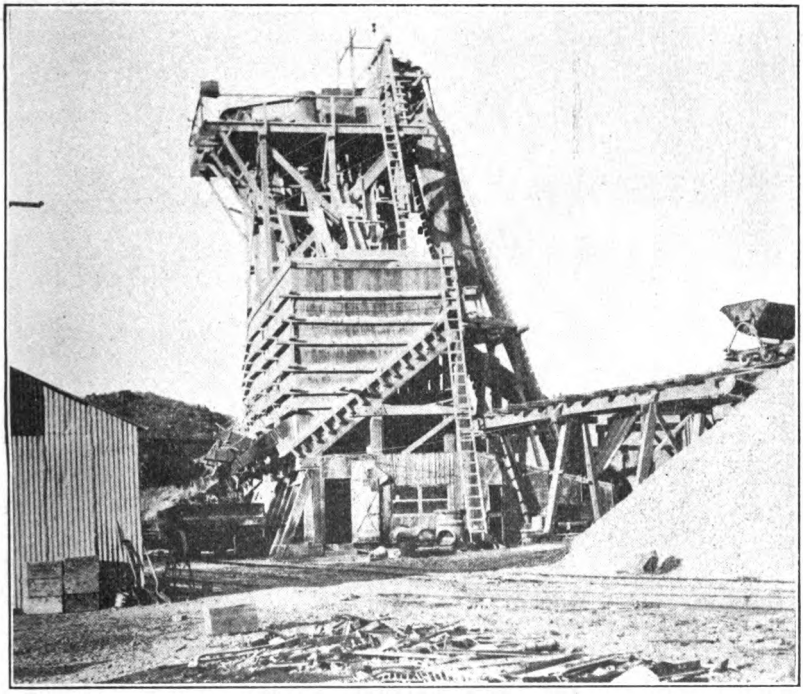


Sweetwater Quarry, San Diego Stone Co. Sweetwater Dam and Mt. St. Miguel. F.J.H.M. Photo.

Fenton-Sumption-Barnes Company, 168 Tenth street. H. G. Fenton, president; H. W. Sumption, secretary. This company produces gravel and sand from the valley of the Otay river and sand from the Tia Juana Valley. The sand consists of two grades; coarse for concrete and fine for mortar. The gravel is produced in two sizes; one inch and inch and a half. Crushed stone is also produced from cobbles and sold in one inch size. About half of the sand comes from the gravel washing plant in the Otay River Valley. Here the company controls 160 acres along the stream bed in Secs. 22 and 23, the plant being in NW. ¼ of the SW. ¼ of Sec. 22. The company also works a deposit of sand in the

SE. of Sec. 1, near Tia Juana. Other sand tracks are controlled near Riverview and Lakeside, each about three quarters of a mile long and comprising 100 acres. The sand here is loaded with a locomotive crane and sold in its natural state. The plant began operations in June, 1912, and from that time until May, 1913, were shipped 5,859 cars of 25 tons each, two thirds of these being of crushed stone and one third sand. From the plant at Otay shipments amount to 350 cars per month.

The Sylvan Gravel Company, J. P. Stibolt, president and manager, J. Brown, secretary.



Crushing and Screening Plant. Sweetwater Quarry, San Diego Stone Co. F.J.H.M. Photo.

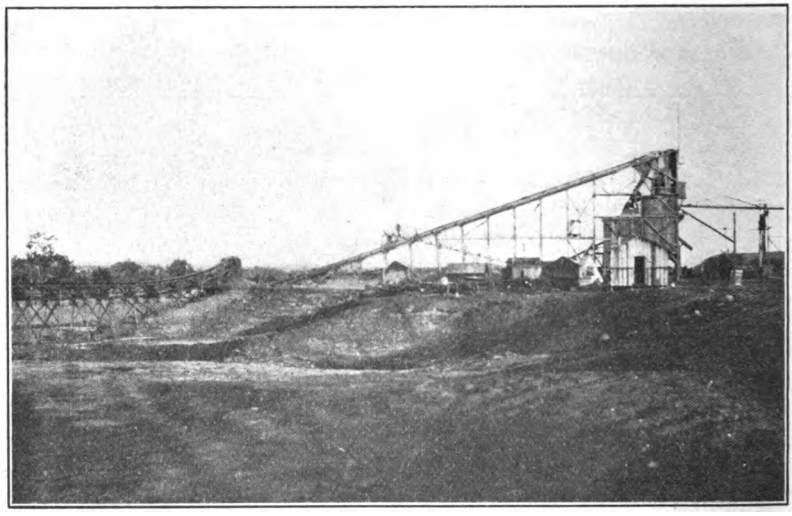
This company operates a plant in Rose Canyon near Selwyn station, using gravel and cobble stones from the arroyo bottom. A small crushing plant is in operation. The city office is at the southwest corner of Eighth and M streets.

The Mission Rock Company, 111 C street, L. T. Daley, president; Geo. W. Pierce, secretary.

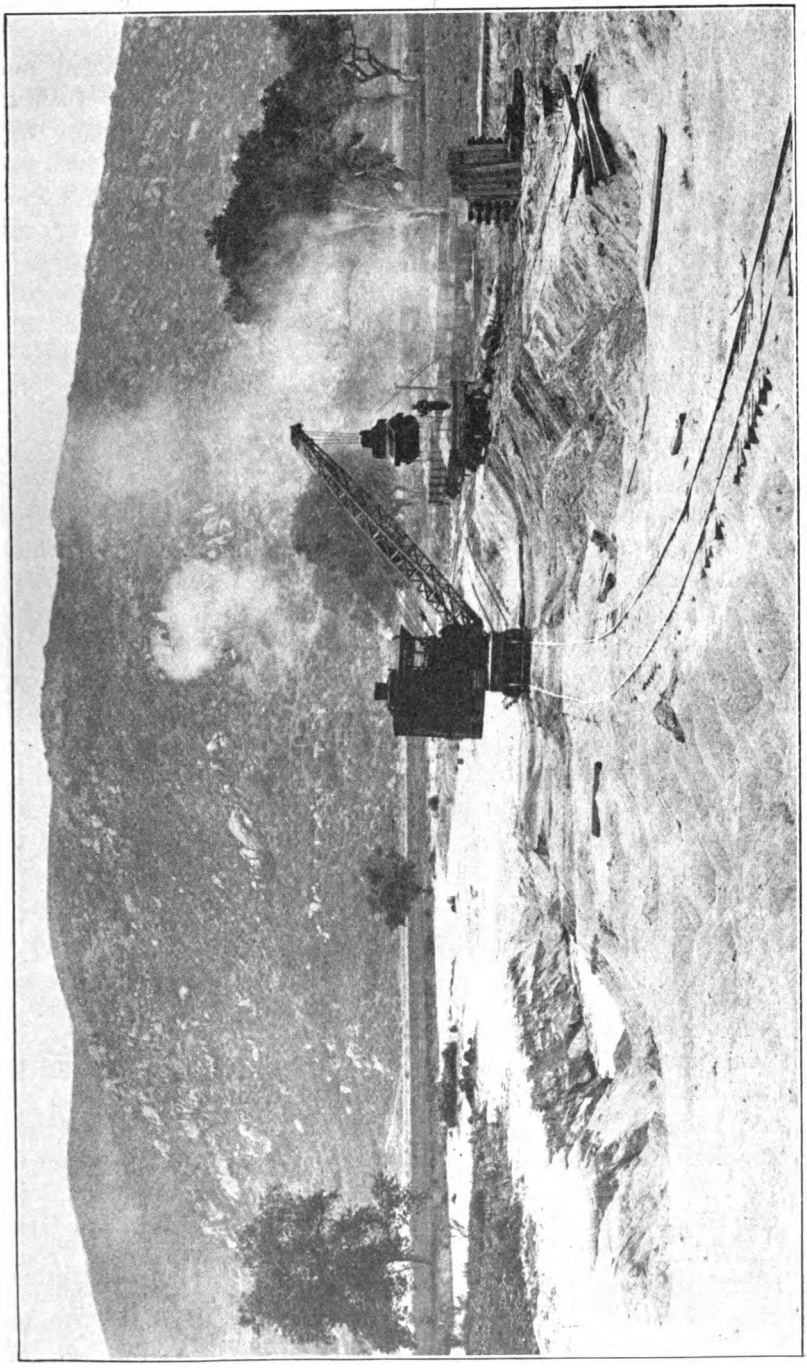
This company operates a plant in Murphy's Canyon, north of the Mission Valley. The chief product is crushed cobble stones. Having been in operation only since August, 1913, it has not yet attained much

production. Its capacity is 50 tons per day, using a No. 3 Austin gyratory crusher. A washing plant is now being installed.

In the Mission Valley several other companies have gathered sand for building and marketed it in San Diego. In the northern part of the City, east of the State Normal School, a small portable plant is operated by Ole Nelson for crushing cobble stones for concrete.



Sand and Gravel Washing Plant. Fenton-Sumption-Barnes Co.
Otay River Valley. F.J.H.M. Photo.



Loading River Sand near Foster. Independent Stone Co.

LIME.

Lime (CaO) is the oxide of the metal calcium and, in some form is the basis of all mortars and cements used for building. When comparatively pure it is common lime, or quicklime. When mixed with a small percentage of clay or silica it forms poor or meager limes, with the increase of clay it forms hydraulic lime, and when mixed with clay in proper proportions and properly burned and ground it forms Portland cement. Lime combined with sulphuric acid forms calcium sulphate, which occurs in nature as gypsum and makes plaster of paris.

The numerous beet sugar factories in this state use large quantities of lime, several quarries being operated for these factories alone. The manufacture of beet sugar being liable to increase in the near future, an increased demand for lime for this purpose can be expected. The remainder of the product is used for furnace flux, as a fertilizer, for mortar and plaster in building operations, in glass manufacture, and other minor industries.

Lime is produced commercially, by heating limestone in furnaces known as limekilns. Limestone consists of calcium carbonate, which, when sufficiently heated loses its carbon dioxide, which escapes as a gas, and the quicklime remains. Limestone begins to lose carbon dioxide at about 750° F., but requires a temperature of over 1300° F. before it is driven off. In chemically pure carbonate, there are 56 per cent of lime and 44 per cent of carbon dioxide, but there are also nearly always present, some moisture and organic matter, which are driven off, and varying percentages of clay, magnesia, iron oxide, etc., which are not driven off, in the burning. So the resulting lime may vary from 56 per cent to 30 per cent or less of the stone. Moisture in the stone facilitates the burning, so that a freshly quarried, moist stone is more readily reduced than a dry one. Hence a dense, compact stone is reduced with greater difficulty than a porous one, but the quality of lime is better.

Lime and cement, as materials of construction, are so important in the development of a city like San Diego, that there is little doubt that in the near future, lime will be burned within the county and that the necessary association of lime and clay will be found at some point conveniently situated for the establishment of a factory for Portland cement. In 1890 a beginning was made with a calcareous deposit on the Jamul grant by the erection of a cement factory.[1] It was found, however, that at that time, it could not be made and delivered in San Diego in competition with European Portland cement brought by water freight. This deposit, with the whole of the Jamul Grant, belongs to J. D. Spreckels and has been carefully experted for him, but not found of sufficient promise to justify further operations. As railroads are built through the country and, with the perfection of the automobile

[1] R. IX, pp. 139 and 309–11; XI, p. 383.

truck, means will be found to make these valuable materials and bring them to market at reasonable prices.

Calcareous materials are not especially abundant in the western part of the county, for the Tertiary deposits conceal palæozoic and mesozoic strata which may be calcareous. We must, therefore, look chiefly to the country east of the mesas where, in the metamorphic formations, are numerous limestone outcrops. One of these is near Deer Park east of the Cuyamaca Grant,[2] another is in the area east of Warner's ranch. On the road to Oak Grove there is said to be an old limekiln near Deadman's Hole. On the eastern slope of the divide, in the region of Jacumba and northward from that point, an abundance of limestone is reported. An outcrop of this material occurs 4½ miles northwest of Borrego Springs. Some of these deposits will be made accessible by the San Diego and Arizona Railway, now under construction.

In the mesa itself, near Otay, is a calcareous layer not far below the surface. A similar deposit occurs near Lemon Grove, but these are of insufficient thickness, so far as known, to be of commercial interest.

BRICK CLAY.

At the outset, surface clays were generally used in San Diego for the manufacture of brick, but it has been discovered that, in the bluffs of Rose Canyon, about 10 miles north of the city, are extensive exposures of Eocene Tertiary clay or shale, extending for a distance of some 3 miles north from Ladrillo on the Atchison, Topeka and Santa Fe Railway, and well adapted for making brick and building tile and easy of access through their nearness to the railroad. Consequently, now, all the brick companies are using this shale in their manufactures and all but one have located their plant in this canyon. At some points, certain layers of this shale exhibit the property of vitrifaction, but no vitrified brick is yet being manufactured.

While as yet out of reach, in regard to transportation, attention must be drawn to the great areas of Miocene Tertiary clays which occur on the eastern margin of the county, where the deposits of the Salton Basin lie in the re-entrant bays of the granite ranges. (See geologic map.) The extent of these is very great, amounting to several hundred square miles, but little is known of their properties.

BRICK.

San Diego Brick Manufacturers.

Bulletin 38, page 254.

The following companies and individuals are now engaged in the manufacture of brick and building tile:

F. L. Hieatt Brick Co., F. L. Hieatt, president; J. R. Jolly, secretary. Plant, corner California and Juniper streets. Now using Tertiary

[2]See Marble.

clay from Ladrillo in Rose Canyon. The plant consists of 1 dry press, 18,000 daily capacity, and 1 stiff mud machine, 60,000 daily capacity. Electric power is used and about 20 men are employed. Oil is used to heat the kilns.

Union Brick Co., corner Twenty-third and Pierce streets. This company, formerly in San Diego, has recently moved its plant to Rose Canyon.

R. M. Hubbard, 548 Spreckels Theater Building. This plant is in Rose Canyon near Ladrillo in Pueblo Lot 1787. The equipment is a Penfield stock machine using electric power; 20 to 25 men are employed. These kilns are heated with crude oil.

Rose Canyon Brick Co. Plant near Ladrillo. J. S. Akerman, 1311 E. First street. This plant is now idle.

San Diego Vitrified Brick and Clay Products Co., president, C. E. Anthony; secretary, C. H. Anthony. Office, 858 Fourth street. This company controls 100 acres of Tertiary clay on Rose Canyon, in Pueblo Lot 1267. The equipment is one dry press of 20,000 capacity, operated by electric power. The company claims superior vitrifying properties for the clay which it controls and proposes to manufacture paving brick and other similar products.

Sunnyside Brick and Tile Co. This company is also in Rose Canyon, west of the preceding.

In addition to the brick made in San Diego, a large quantity is shipped in from Los Angeles.

POTTERY MATERIALS.

Bulletin 38, page 227.

Pottery clay, kaolin, feldspar and quartz have long been known in San Diego County, but, until recently, no one had invested the capital necessary to carefully investigate and utilize them. This work has recently been undertaken by the California China Products Company, Walter Nordhoff, president, C. H. Nordhoff, secretary, which has erected a plant on Twelfth street, National City. This comprises all necessary clay working machinery together with two 18-foot and one 14-foot down-draft kilns. Oil is used as fuel, and electricity for power. About 25 men are employed.

This company was founded to make fine china of the French type, and the proper clays for this purpose were found and located or bought. But on investigation of the labor question it was found to be impossible to make such china commercially in California. A change of plan was therefore made, and, using some of the same materials and others afterward located or bought, the manufacture of glazed Faience tile was begun. This proved so successful that, in addition to mantel and hearth Faience, the extended use of the glazed tile has become common

in wainscots and in both interior and exterior floors, whether exposed to sun and rain or protected or partially protected. Its use has been specified for the exterior of the great dome of the California State Building at the San Diego Exposition, and also for floors and wainscots in the New York State Building at the San Francisco Exposition. It has also been used in the better class of stores and club buildings throughout the coast, and is being shipped to New York and successfully sold there in competition with the best American and imported tile. In addition to this Faience tile, experiments have been finished and clay deposits located or bought, which will enable this company to produce in future as they desire, sanitary ware of first rate quality, high tension electric insulators, yellow mixing bowls, and quarry or mission blocks for flooring.

Owing to the labor cost, the company does not propose to manufacture china in any form, but the products specified above will be gradually introduced. The yellow mixing bowls are about ready to go on the market. Only California clays and California labor are used in the manufacture of these products.

The raw materials investigated by this company are from various sources. The larger part of the clay used is from Aberhill, Riverside County. From San Diego County they have experimented with the following:

Kaolin, from the west peak of Cajon Mountain. This has long been known and was mentioned in Bulletin 38, page 227. Besides this locality it has been reported from San Vicente Mountain, Poway and Lyons Peak.

Feldspar, from Sec. 27, T. 16 S., R. 1 E. This is southwest of Dehesa.

Quartz, was obtained from a deposit southeast of El Cajon Mountain.

Yellow burning non-plastic clay, almost fire clay, was obtained near La Costa station. This clay is on the Huchting Ranch and lies in the NE. ¼ of Sec. 25, T. 13 S., R. 4 W.

The use of these materials is still in the experimental stage and no detailed information is available concerning their qualities. Since the writer's visit he is informed that their use has been discontinued.

A deposit of white clay, fit for fire brick, lies on the Kelly Estate, near Farr Station, 7 miles south of Oceanside. This is leased by the F. L. Hieatt Brick Company of San Diego.

No doubt many other deposits will be found in San Diego County, since the great granite ranges must have yielded, by their decay, vast amounts of feldspathic material, but only exhaustive tests by manufacturing interests will definitely determine their value. Mere chemical analysis is suggestive but not final.

Near the plant of the California China Products Company, on Twelfth street, National City, is the workshop of the Markham pot-

teries. This is a new industry recently established by H. C. and K. S. Markham, formerly of Detroit, Michigan, who are preparing to make art pottery of various types, using the Nordhoff kilns for the final execution of the work. It is hoped that this enterprise will prove entirely successful.

GLASS SAND.

Near Boulevard and about one half mile from the surveyed line of the San Diego and Arizona Railroad are three deposits of pure white quartz. They are reported to be free from iron and other impurities and would therefore be adapted to the manufacture of plate glass, porcelain, fluxes and for many uses in the arts. High grade silica is scarce in this region and these deposits appear to be of the best grade.

SAPONITE.

Three miles southeast of Otay there is a deposit of this mineral, a massive, clay-like variety of kaolin, containing a great amount of combined water. It is locally known as "mineral soap" and was mentioned by W. A. Goodyear as montmorillonite, R. IX, p. 139. It forms a layer from 2 to 5 feet thick a few feet below the surface of the mesa and underlying several hundred acres. Outcrops have been seen at several points in the bluffs of the Otay River Valley. No commercial use has yet been found for this material.

GYPSUM.

The principal deposits of this material are just over the line in Imperial county and will be described under that head. Small deposits are reported in San Diego County, just west of those above referred to and the Carrizo Creek clays contain plates of selenite, the transparent form of this mineral.

ASBESTOS.

Bulletin 38, page 263.

Two distinct minerals are known in the market as asbestos. One is a form of actinolite, or of tremolite, which are varieties of hornblende, a silicate of lime, magnesia and iron, and has fine, soft, flexible fibers like cotton. Most of the commercial asbestos, however, is a variety of serpentine, called chrysotile or amianthus, a hydrous silicate of magnesia, containing about 14 per cent of water. Though, in many hespects, both varieties possess similar physical properties, and the heat-resisting qualities of both varieties are about equal, the chrysotile variety is superior to amphibole asbestos is strength and elasticity. Consequently, for all purposes in which non-conductivity of heat is the important factor and not strength of fiber, as in fireproof paint, wall plaster, boiler and steam pipe covering, fireproof packing of safes, etc., both

varieties can be used. Infusorial earth, talc and mica are strong competitors of asbestos in these lines.

In the manufacture of cloth, rope, felt boards, tubes, washers, and blocks of various shapes, strength of fiber is essential, as well as non-conductivity, and only the chrysotile variety can be used. The fibers of chrysotile are usually from one half to 1½ inches in length, and seldom exceed 2½ inches.

Mill fiber, a paper stock, is made of minute fibers of asbestos which have become broken and are not available for weaving. Asbestic is the final waste material, which contains a small amount of minute fibers and a considerable amount of crushed serpentine rock.

In San Diego County, small deposits of good fiber are reported in the mountains three miles east of Warner's Hot Springs. See R. IX, p. 148. No doubt, in time, other deposits will be discovered.

MICA.

This name includes several species, the most important commercially being muscovite and biotite, which are silicates of alumina, with potash, magnesia and iron. Cleaving in thin, transparent plates and resisting heat, muscovite is used for stove doors. For its non-conductivity of electricity, it is used as an insulator in electrical appliances. Pulverized, it is used to give a brilliant surface to wall paper. Biotite, lacking transparency, is chiefly used ground fine as an insulator against heat in fireproof safes. This material is not abundant in San Diego County, but some good sized plates of light colored biotite have been brought from a prospect near Jacumba. This information is furnished by Mr. W. H. Trenchard, of San Diego.

MINERAL PAINT.

For exterior work oxides of iron and manganese are extensively used as well as various colored earths or ochers, which owe their shades of red, brown and yellow to the metallic oxides present. Such materials can be found at several points in this county but thus far no use has been made of them.

The principal deposit which now merits attention as a source of paint is about 8 miles southwest of Escondido and about the same distance from Encinitas in the south half of Sec. 3, T. 13 S., R. 3 W. Here is a bedded deposit of the mineral pinite, usually referred to as palagonite. This, however, is probably an error of spelling for *paragonite,* since palagonite is a deposit of volcanic glass. Claims known as White Hawk, Ocean View and Pinite Queen were located here prior to 1902, and after several experiments in utilizing the material commercially and some financial mishaps the locations passed successively through the Palagonite Industrial Mining Company and the Premier

Investment Company, both of San Francisco, and now are held by the Pacific Paint Products Company, I. P. Janssen, president, J. E. Neal, secretary, 709 Central Building, Los Angeles. This corporation is about to build a factory near the Santa Fe Railway tracks, between Fifty-fourth and Fifty-fifth streets, Los Angeles. Through the courtesy of Mr. Janssen, I am able to quote from the report of a careful examination of the properties by Smith, Emery & Company, of San Francisco.

The deposit is traceable for a distance of some 4,000 feet, its streak being nearly east and west and its dip 45° north. It varies from 70 to 100 feet in width and is underlain by diorite, which forms the foot wall, while the hanging wall is of basalt. Near the foot wall the color is reddish and yellowish, while toward the hanging wall it grows lighter in shade, passing through light yellow and gray to white. The portion available commercially is described as averaging 12 to 15 feet in width.

Analyses by Smith, Emery & Company give the following results:

White.

Silica (SiO_2)	67.47%
Alumina (Al_2O_3)	20.38%
Iron oxide (Fe_2O_3)	1.85%
Lime (CaO)	.09%
Magnesia (MgO)	.13%
Loss in ignition	7.82%
Alkalies (by differences)	2.31%
Total	100.00%

Gray.

Silica (SiO_2)	66.58%
Alumina (Al_2O_3)	21.07%
Iron oxide (Fe_2O_3)	1.98%
Lime (CaO)	.12%
Magnesia (MgO)	.10%
Loss in ignition	8.26%
Alkalies (by differences)	1.94%
Total	100.00%

It is stated that the colored portions of the deposit are very suitable for pigment, both for exterior use and for kalsomine. It is further suggested that the material may successfully be used for polishing powder, paper filler, cosmetic, putty, working crayons, and talcum powder. The report also states that it is available for making tips for coal gas and acetylene burners.

With all these possibilities it is to be hoped that the owners will find no further difficulty in making a commercial success. Probably this material was deposited as a volcanic tufa and since the writer has observed white tufas at other points it may be that similar material will be discovered elsewhere in the county.

East of Warner there is a deposit of ochre which as yet has been but slightly prospected. F. B. Hahn, formerly of 1850 North Main street, Los Angeles, is the owner.

GEMS.

The gem minerals of California have been described at great length in Bulletin 37 of the State Mining Bureau, by Dr. George F. Kunz, of New York City, whose long experience and commanding position in the gem trade of America have given him exceptional opportunities for knowing of the material produced and judging of its quality. In that bulletin is much invaluable, historic and descriptive detail relating to gems mined in San Diego County, which can not here be repeated. Since this most valuable bulletin is still for sale, those wishing minute detail regarding the occurrence and character of the gems are referred to it for more complete information. The purpose of this article is to concisely review the subject and supply all details which have become current since 1905, when Bulletin 37 was issued, together with some facts hitherto omitted. Also, the geology of the deposits more fully discussed and the relation and position of the principal mines are defined more accurately than heretofore, since in Bulletin 37 some of the section numbers are incorrect.

The gem industry of this county has at times attained considerable prominence though at present much depressed. At the time of the writer's visit none of the gem mines were in operation. This is partly due to a decline in the demand for San Diego County gems. For a long time there was an active demand by Chinese merchants for the red tourmaline which is highly prized in their country, and this served as an outlet for the material of medium quality so that the finest specimens of gem quality could be used for local consumption in the tourist trade, or sent to the New York market. With the death of the Dowager Empress of China and the outbreak of the revolution in that country the demand for such luxuries was suspended and at present, there being no market for medium quality tourmalines, it hardly pays to work the mines. Good specimens of kunzite find a ready sale, but the principal source of this material, the Pala Chief mine, has not been recently in operation. The other gems, while very beautiful, are not now in sufficient demand to create an active market.

The list of San Diego County gems and gem minerals is large and interesting and comprises 17 species which may logically be arranged in two groups, (A) those of commercial interest and (B) those not yet commercially important.

(A) GEM MINERALS OF COMMERCIAL INTEREST.

Name	Localities
Topaz	Ramona.
Spinel	Rincon.
Beryl	Pala; Mesa Grande; Ramona; Aguanga Mountain; Jacumba.
Garnet	Ramona; Cajon Mountain; near San Vicente; northeast of Jacumba.
Tourmaline	Pala; Moosa Canyon; Mesa Grande; Aguanga Mountain.
Spodumene (Kunzite)	Pala.

It should be noted that fine specimens of these minerals are in demand for mineralogical collections in museums as well as for gems, and in this way possess commercial interest apart from their value to the lapidary. Further they are not only commercially important, but also in this county they all occur in pegmatite dikes and therefore, in their geologic relations, must be discussed together. For a minute description of the gems found in the San Diego mines the reader is referred to Bulletin 37, for Dr. Kunz having had the opportunity of seeing all the best material, his descriptions are detailed and authoritative. For this report a condensed summary must suffice but in several cases the writer has freely used Dr. Kunz's statements.

Topaz: Bull. 37, pp. 46–47.

Silico-fluoride of alumina.

H. 8; G. 3.4–3.6. Brittle, luster vitreous. Color yellow to brown and pale green to blue, often colorless.

The chief locality in this county is Ramona, where in the Little 3 and Surprise mines were found crystals varying in color from white, light yellow and sea green to sky blue. Some of these were over a pound in weight.

Spinel: Bull. 37, p. 47.

Aluminate of magnesia, often with iron oxide.

H. 8, G. 3.52–4.1.

Color usually various shades of red. At Rincon, in the Mack mine, blue crystals of small size have been found.

Beryl: Bull. 37, pp. 48–50.

Silicate of alumina and glucina.

H. 7, 5–8, G. 2.7.

Luster vitreous. Color green, yellow and white to rose red.

The more familiar forms of this mineral are the rich green gem known as emerald and the sky blue and sea green stone called aquamarine.

In San Diego County rose colored beryls have been found in the Himalaya mine at Mesa Grande and on Aguanga Mountain. The principal specimen from the latter weighs nearly 2 pounds and is in the United States National Museum. Other beryls of pink color have been found in the Katrina Mine at Pala; in the Esmeralda mine at Mesa

Grande, together with golden beryl and aquamarine; both pink and green shades at the Crystal Gem mine, 8 miles northwest of Jacumba, and in the Surprise and A B C mines at Ramona. Golden beryl has been found 1 mile northwest of Jacumba. Other beryls are reported from the Hercules and Lookout mines at Ramona and the Mack mine near Rincon has produced very beautiful aquamarines.

Garnet: Bull. 37. pp. 50–54.

Silicate of alumina, lime, magnesia, iron, manganese, chromium, or titanium.

H. 6.5. G. 3.15–4.3.

According to composition they are mineralogically classed as follows:

Alumina Garnet	Alumina-iron, *Almandite,* cherry red to deep red.
	Alumina-manganese, *Spessartite,* red brown and orange red.
	Alumina-lime, *Grossularite,* var. essonite, white, yellow, brown to red.
	Alumina-magnesia, *Pyrope,* blood red to black.
Iron Garnet	Iron-lime, *Andradite,* yellow or orange brown.
Chromium Garnet	Chromium-lime, *Ouvarovite,* emerald green.

By jewelers these stones are classed more by color than by chemical composition. Essonite has been found in limestone at several points 9 to 10 miles northeast of Jacumba, also near San Vicente. The finest crystals have been found at Ramona in the Hercules, Lookout, Surprise and Prospect mines. From some of these, gems have been cut up to 6 and 8 carats weight.

Tourmaline: Bull. 37, pp. 54–63.

Silicate of alumina, magnesia, iron, boron and alkalies (soda, potash, lithia) with small amounts of water and fluorine.

H. 7–7.5. G. 3–3.2.

Brittle, luster vitreous. Colors, black, blue, green, yellow, red, brown, colorless. The red or pink variety, called rubellite, is highly prized by the Chinese.

Gem tourmalines were first found in this county at Mesa Grande about 1895. The rubellite in lepidolite at Pala was first reported in 1890. Mesa Grande has yielded perhaps the largest number of fine crystals. The two-color stones, red and green, are especially fine. Dr. Kunz estimates that $30,000 worth of mineralogical specimens have been obtained here and that the gems aggregate up to 1905, some $200,000. The Pala Chief mine and the Hiriart Mountain claims have also yielded much valuable material.

Spodumene: (var. Kunzite) Bull. 37, pp. 81–93.

Silicate of alumina and lithia, usually with a little sodium.

H. 7–7.5. G. 3.19. Brittle, luster vitreous, on cleavage surfaces pearly. Lamellar structure parallel to vertical axis.

This handsome lilac and pale pink to white spodumene discovered in 1902 and found only at Pala in this county, and at the Fano mine near Coahuila in Riverside County, has become of world-wide interest. The darker stones are especially beautiful but are said to fade slightly after long exposure to light. The Pala Chief and White Queen mines at Pala are the chief sources, but the former has yielded the largest masses. Some very large specimens have been found weighing up to 24 ounces.

THE PEGMATITE DIKES AND THE GEM VEINS.

It has long been known that in San Diego and Riverside counties the principal sources of tourmaline, kunzite and garnet, together with the less abundant beryl, topaz and spinel, are pegmatite dikes of large size and substantial extent, often occurring in diorite or gabbro.

Pegmatite is a granitic rock consisting of quartz and feldspar together with mica which, in a fluid state, has been injected into fissures in some other rock, under conditions which have permitted its material to cool slowly and its constituent minerals to crystallize and develop freely and fully and therefore to form large masses.

In all the gem-bearing dikes the outer zone or marginal portion at both sides is a micaless granite or aplite, a granular mixture of quartz and feldspar of moderately fine grain, owing its texture and condition to the more rapid cooling of the material at its contact with the country rock. Within a second zone, where cooling was more gradual, the feldspar and quartz appear in larger masses, and other minerals show themselves. Generally the first foreign mineral to appear is black tourmaline in its characteristic long prisms, usually imbedded in quartz. Garnet crystals, of small dimensions, are often visible, which through their higher gravity, when the dike lies nearly flat, gather in its lower portion, forming lines or bands and giving rise to the name of "Line rock." Graphic granite, a massive development of feldspar with angular quartz inclusions, also abounds in the second zone. The third or central zone is more irregular in the arrangement of its minerals and contains cavities of substantial size, bordered by and containing large crystals of quartz and feldspar. Filling these cavities in the Stewart vein at Pala are found the lithia minerals, lepidolite and amblygonite, and in the gem-bearing veins are found tourmaline; spodumene, var. kunzite; beryl, topaz and garnet; for the most part enclosed in a clay-like substance* which fills the cavities.

On account of these details of interior structure some observers have described the whole dike as a vein, but the conditions are clearly more complex. Through movements of the earth's crust, which resulted in the opening of wide fissures, the pegmatite dike material found its way toward the surface, but the fissures remained planes of movement

*W. T. Schaller, Am. Jour. Sci., Vol. XVII, p. 191.

and after the central portion of the dike had fully cooled and hardened, or perhaps even before, it was shattered and a new fissure opened through which gem forming mineral solutions might pass. Thus within the dike was formed a vein. In several of these dikes are undoubted fissures and gouges, particularly in the Tourmaline Queen, and there is evidence to confirm the view that the shoot-like cavities in which the gems occur, are portions of fault fissures within the dikes. It is true, all of the gems are not free in the clay, for some are locked or "frozen" into crystals of quartz. This, however, is unquestionably due to silicious solutions which flowed up through the secondary fissures and formed the quartz crystals which abound in them.

The persistent recurrence over a large area of similar phenomena in connection with these dikes is, indeed, striking. First came an intrusion of granite diorite or gabbro and later an injection of pegmatite into its fissures. Then occurred a secondary fissuring of the pegmatite and a flow of solutions depositing usually tourmaline and sometimes also beryl, kunzite, topaz, or garnet, together with quartz crystals. On the central axis mentioned below lithia minerals everywhere occur.

Such are the dikes which contain the gem bearing veins. Their chief localities are Pala, Rincon, Mesa Grande, Moosa Canyon, Ramona and Aguanga Mountain.

By referring to the accompanying economic map on which the gem and lepidolite deposits have been plotted, it will be seen that Pala, Rincon and Mesa Grande lie in a line which bears about north 50° west and therefore coincides in general direction with the axis of the granite ranges and the strike of the metamorphic rocks. These gem deposits and the lepidolite deposit on Granite Mountain southeast of Banner, are on a central axis, Ramona and the Moosa Canyon locality lie in a parallel line about 8 miles southwest, and Aguanga Mountain is about the same distance northeast. The Pala dikes are mostly in diorite, as are those of Aguanga Mountain and Rincon, those at Mesa Grande are in gabbro and the others are in granite. Many conclusions might be drawn which would require further field work to confirm them, but the repeated occurrence of the lithia minerals, kunzite and lepidolite, in a gem-bearing zone 40 miles long, is highly interesting. The Riverside County kunzite locality near Coahuila lies some 23 miles northeast of the San Diego zone.

THE GEM DEPOSITS.

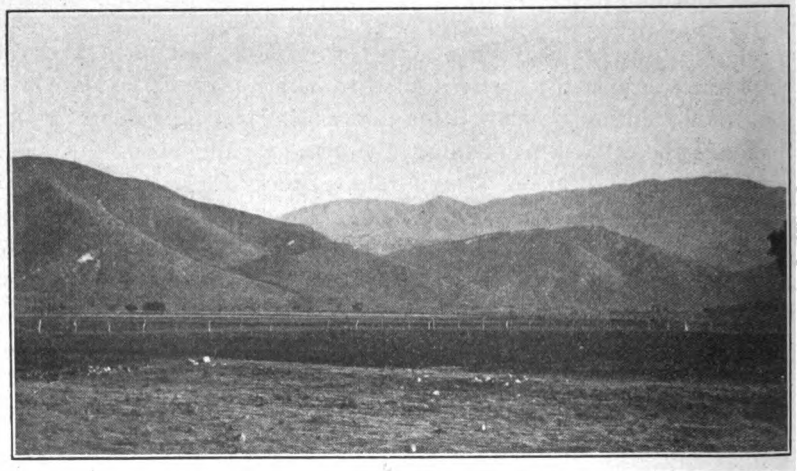
Pala.

Pala is a small village on the Indian Reservation of that name, in the valley of San Luis Rey River, about 28 miles from Oceanside. It takes its name from the Franciscan mission chapel of San Antonio de Pala. The gem bearing dikes here occur in three hills, or small moun-

tains, immediately north and east from Pala village, rising 1,000 feet or more above the plain of the San Luis Rey River and lying within Secs. 13, 14, 15, 22, 23, 24 and 25, T. 9 S., R. 1 W., S. B. M. The dikes are of exceptional size and penetrate a country rock of granite and diorite. In several cases, erosion has removed the country rock above the dike or, in miner's parlance, the "hanging wall," so that the dike itself, for some distance, forms the surface of the mountain slope and is described by miners as a "blanket vein."

The westernmost hill, 1,800 feet high, called Tourmaline Queen mountain,[1] is cut by 4 approximately parallel dikes of slight southwesterly dip, the 3 lower being nearly horizontal in their intersection with the east face of the mountain. The lowest is of small thickness and

Tourmaline Queen Mountain. Pala Chief Mountain.



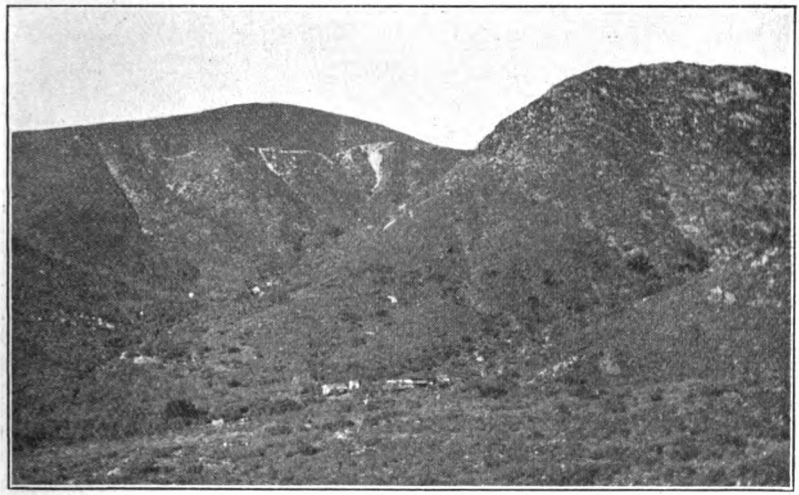
Tourmaline Queen Mountain and Pala Chief Mountain. Looking Northeast from Pala. F.J.H.M. Photo.

minor importance, being known as the Douglass vein, from the Douglass claim located upon it. The next in altitude, on which are the Stewart and Mission claims of the American Lithia and Chemical Company, is about 400 feet above the arroyo bottom. This is exposed for a distance of 3,000 feet or more on the east side of the mountain, and its line of outcrops has a southward pitch of 5° from the horizontal. The chief feature of this dike, which is 40 feet or more in width, is a vein of lepidolite 10 to 20 feet thick, lying along the central plane. In the upper portion of this, at intervals, have been found pockets of amblygonite or lithia phosphate. The red tourmaline, rubellite, abounds imbedded in the lepidolite, in radiating masses. No abundance of gems has been found in this vein, but light pink kunzite and some gem tour-

[1]Incorrectly called Pala Mt. in Bull. 37. Pala Mt. lies SE. and has no gem bearing dikes or veins.

maline have been taken from the north end of the Stewart claim and considerable quantities of small but fine green tourmalines have been taken from the Gem lepidolite mine, belonging to A. M. Labaugh, which adjoins the Stewart claim on the north. South of the Stewart is the Mission claim, on the south face of the hill and, on patented land still farther south, is the old Alvarado mine.

About 600 feet above the Lithia Company's dike and parallel to it, is the Tourmaline Queen dike. Its outcrop is hundreds of feet in length, its extent to the south having been limited by the erosion of the hill. The claim which bears this name is partly in Sec. 15 and partly in Sec. 22. The workings on it are quite extensive. This dike is about



Tourmaline Queen Mine. Looking West from Pala Chief. F.J.H.M. Photo.

14 feet wide and dips southwest 15°. On this mountain are also the Pala King and Homestake claims.

Dr. Eakle determines the country rock of the Tourmaline Queen as hornblende-diorite. A thin section shows large broad plates of dark green hornblende and plagioclase feldspar as essentially composing the rock. Smaller amounts of orthoclase and some irregular grains of magnetite are present.

Still higher, on the Tourmaline Queen Mountain is the Tourmaline King mine, belonging to F. B. Schuyler, of Berkeley, Cal. The outcrop is on the north face of the summit peak, the vein being about 7 feet wide and dipping 40° southwest. Other minor claims on the south face of this mountain are Maud and Happy Hooligan, also Buster Brown, formerly White Cloud, belonging to John Reed, of Fallbrook, and Adolph Shoulders, of Pala.

Pala Chief dike is the largest of all the gem bearing pegmatites. As the photograph shows, it is exposed on the west side of the summit of a hill, about 1,500 feet in height. It is about 1 mile east of Tourmaline Queen and lies mainly in the SE. ¼ of Sec. 14. Its thickness seems to vary from 30 to 50 feet and it dips about 15° west. The hanging wall appears to be a mica diorite and the foot wall a granite, but over a considerable area the hanging wall has been removed by erosion so that it has been called a "blanket vein." The gem material, chiefly kunzite, occurs in a reddish clay in pocket of considerable size. One of these was 3½ feet high and 20 feet long. Lepidolite in small masses is of frequent occurrence.

Pala Chief Mine. Hiriart Mountain.

Pala Chief Mine and Hiriart Mountain. Looking Eastward from Tourmaline Queen Mountain. F.J.H.M. Photo.

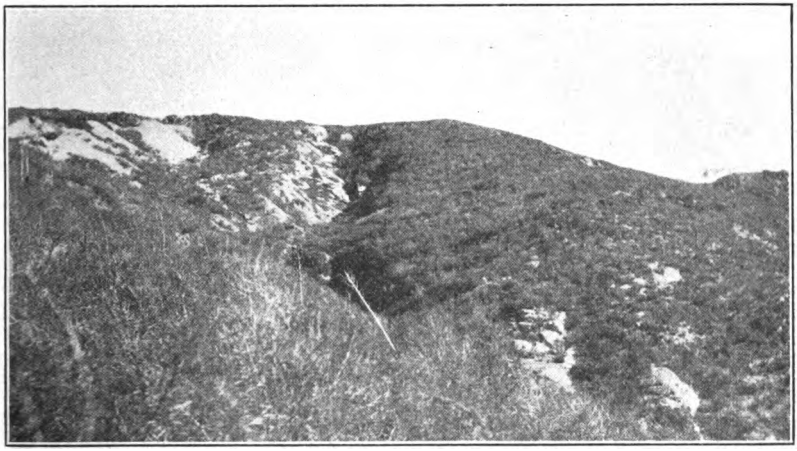
The following are Dr. Eakle's determinations of the wall rocks:

Hanging-wall, dark hornblende-diorite. A thin section shows the rock to consist almost wholly of plagioclase feldspar and fibrous green hornblende. Magnetite occurs scattered throughout.

Foot wall, biotite-granite. A disintegrated granitic rock. A thin section shows biotite flakes, little plagioclase, considerable orthoclase and small amounts of quartz and hornblende. An occasional titanite crystal is seen.

The Pala Chief claim is one of a group of 5, the others being Ocean View, Goddess, Hazel W. and Knickerbocker. This group, together with the Tourmaline Queen, Pala King and Homestake, is controlled by the Pala Chief Gem Mining Company, of San Diego, Frank A. Salmons, president; R. Fenton, secretary.

South of the Knickerbocker claim is the Olla, owned by John Reed and Adolph Shoulders. South of Olla is Butterfly, owned by T. A. Blakely, of San Bernardino. This has produced some pink kunzite.



Pala Chief Dike and Mine, Looking East. F.J.H.M. Photo.

West of Hazel W. lies Redlands King, belonging to Mascart, of Redlands. East of Knickerbocker and Olla and south of Goddess is Redwings, belonging to B. T. Cooper, of Pala. This claim has yielded aquamarine beryls of inferior quality.

Hiriart Mountain. This hill, about 1,700 feet high, lies about 1½ miles southeast of Pala Chief, mainly in the SE. ¼ of Sec. 24, T. 9 S., R. 2 W., extending into Sec. 25. Here are numerous pegmatite

Mammoth Quartz Crystals. Pala Chief Mine.

dikes, varying in direction and dip, as shown in the photograph. The claims located on these are in 3 groups, based on ownership.

(A) Domingo Hiriart, Pala.
San Pedro.
Senpa.
Anita.

(B) M. M. Sickler, Pala.
K. C. Naylor.
Vanderberg.
White Queen.
Center Drive.
Fargo.
El Molino.
Hiriart.

(C) M. M. Sickler and D. Hiriart, Pala.
Katrina.

The White Queen claim is of historic interest as being the source, in 1902, of the first specimens of Kunzite discovered. This material was sent to Dr. G. F. Kunz, in New York, who identified it as Spodumene and subsequently it was given the variety name of Kunzite by Professor Charles Baskerville.

RINCON.

Bull. 37, pp. 137–39.

Gems have been found on the east side of the Rincon Indian Reservation between Pala and Mesa Grande, about 9 miles southeast of the former place. At this point the chief deposit was opened by J. W. Mack and is known as the Mack mine. It lies in Sec. 25, T. 10 S., R. 1 W. The dike is described as 5 to 6 feet wide with granite footwall and diorite hanging wall. The chief product was beryl of various colors, some of it deep blue. No work has been done here for some years, probably because the pocket became exhausted and the demand was not sufficiently great to justify much expenditure in searching for a new ore.

MESA GRANDE MINES.

Bull. 37, pp. 133–35.

The gem deposits of Mesa Grande lie about 1½ miles northwest of the Indian Rancheria. The principal properties are those formerly operated by the San Diego Tourmaline Mining Company and the Himalaya Mining Company. The latter control the SE. ¼ of SW. ¼ of Sec. 17, T. 11 S., R. 2 E. The holdings of the former are the NE. ¼ of NW. ¼ and NW. ¼ of NE. ¼ of Sec. 20, in the same township and range.

These properties, which adjoin one another, are both on the same fissure, which has been filled with an extensive pegmatite dike. This traverses the two properties, with a serpentine course, in a northwesterly direction for a distance of half a mile, the country rock being a dark green gabbro. The width of the dike varies considerably. At

times its width is somewhat less than that of the drifts which have been cut in it and at times it is greater. The average might be stated at 4 feet. At the contacts on either side, the dike matter is a fine grained aplite but, in the center it is a coarse pegmatite, with frequent cavities, pockets and shoots in which the more perfect specimens of tourmaline and other gem material occur, imbedded in clay.

Dr. A. S. Eakle determines the country rock here to be a hypersthene-gabbro. A thin section shows the rock to mainly consist of labradorite feldspar and rounded crystals and plates of hypersthene with a sprinkling of magnetite. The hypersthene is pale red and shows pleochroism, pale red to pale green.

On the San Diego property the dike winds considerably in its course, and, at the south end of the property, has divided into two diverging forks or spurs. These have not yet been explored as far as the south boundary of the property, and have not been opened on the adjoining claim southward. In the beginning, throughout the two properties, the work was done by open cuts in which the gem bearing mass was mined for a depth of some 20 feet. After this had progressed to a certain point, it was found too expensive to prevent the sides of the open cuts from caving in. This work was, therefore, abandoned and further exploitation of the deposit was made by entering the dike at a lower level and working underground. On the San Diego property two cross cut tunnels were driven, the more southerly of which is over 200 feet long and cuts the two spurs above described. On this property the present level is about 200 feet vertically below the surface of the ground. The ground slopes northward until, on the Himalaya claim, the surface intersects the vein at the adit level. On the latter the main working is by an adit on the north outcrop of the vein, which has been mined for about half the length of the property.

At the present time both properties have been idle for some time. The San Diego tunnel has caved in and access is not at present possible. The Himalaya property is locked up and not open to visitors. The San Diego Tourmaline Mining Company's interests are now represented by Jas. G. Naylor of San Diego. The Himalaya Company is undergoing reorganization and a letter to the New York address brought no reply.

ESMERALDA MINE.

Bull. 37, pp. 136-37.

About 1½ miles west of the Himalaya property and in the east edge of SE. ¼ of SE. ¼ of Sec. 13, T. 11 S., R. 1 E., is the gem mine known as Esmeralda. This property is owned by the Native Gem Mining Company, the controlling interest being held by Dr. C. C. Vallé, Walter N. Burnell, and Mrs. Nicholson, all of San Diego.

Here is a wide dike nearly vertical, and about north and south in its trend, but, a few feet below the surface, branching upward to east and west. The workings are below the fork.

As described in Bulletin 37, this mine at one time produced some very interesting gem material, but it has long been idle and the portals of its adits have caved in. The gems are said to have occurred in pockets of large size but these pockets were somewhat far apart.

MOOSA CANYON.

Bull. 37, p. 62.

The locality is about 12 miles southwest of Pala and 3 or 4 miles southeast of Bonsall. In Bulletin 37, its position is stated to be in Sec. 26, T. 10 S., R. 3 W. The writer was unable to verify this, as one of the owners, Mr. T. A. Freeman, who was interviewed at Bonsall, declined to give any information about the position of the property. Later information, undoubtedly reliable, gives the location of this deposit as in the east half of section 27 of the same township and range.

There are said to be two claims, Vista Chief and Mountain Belle. Tourmalines have been found here, but not in large quantity. The reported occurrence of Kunzite here could not be verified. It is said that tourmalines have been found in Gopher Canyon, which lies 2 miles southwest of Moosa Canyon.

RAMONA.

Bull. 37, pp. 140–150.

The gem deposits here are noteworthy in that the dikes all occur in granite instead of in diorite or gabbro. No mining has been done here for some years, though in assessment work on unpatented claims some gems are produced.

The claims lie in T. 13 S., R. 2 E., on one mineral zone, which includes several dikes, and nearly all are in Sec. 8.

List of Ramona Gem Claims.

	Name	Position	Owner	Address
29	Prospect	SE. ¼ SE. ¼ Sec. 6	H. A. Warnock; John P. Sutherland	Ramona.
30	A. B. C.	Pat. NW. ¼ NW. ¼ Sec. 8	Alexander McIntosh	Ramona.
31	Hercules Group	8 claims, Sec. 8	Dr. E. G. Logan; A. W. Pray	Escondido.
32	Little Three	Pat. NE. ¼ SE. ¼ Sec. 8	Dan McIntosh	Ramona.
			H. W. Robb; Peter Schnack	Escondido.
33	Cable	SE. ¼ NE. ¼ Sec. 8	Dr. Cable	Los Angeles.
	Sunrise	NW. ¼ SE. ¼ Sec. 8	— Batcheller	Ramona.
	Surprise	SW. ¼ SW. ¼ Sec. 9	J. E. Farley; Mrs. G. M. Stone	Ramona.

AGUANGA MOUNTAIN.

Bull. 37, pp. 123–24.

At present only one mine is being worked here. It is the Mountain Lily, 6 miles southeast of Oak Grove, located by Bert Simmons, owned by Dr. C. C. Vallé, of San Diego, and operated under lease by J. W.

Ware & Co., 1414 F street, San Diego. The dike is described as about 4 feet wide in diorite, the gem bearing vein being on the contact between the pegmatite and the hanging wall of diorite.

The special product at this time is a "Nile Green" tourmaline. These stones are very attractive in color but mostly small, not averaging much more than one carat, when cut. Fluorite in small quantity has been found here.

JACUMBA.

Bull. 37, p. 150.

Nine and a half miles east of Jacumba, near Mountain Springs, are some deposits of essonite garnet in crystalline limestone associated with gneiss. Some fine gems have been mined here under the name of California hyacinth. The San Diego Gem Company formerly held claims here, but they have lapsed.

Eight and a half miles northwest of Jacumba is the Crystal Gem mine. Here, in a pegmatite dike, have been found pink and green beryl and essonite garnet. Some 40 miles north of Jacumba, near Seventeen Palms, fine garnets have been reported as abundant.

(B) GEM MINERALS NOT YET COMMERCIALLY IMPORTANT.

The following minerals, while of interest as gems, are insufficiently abundant to be of commercial interest or, while occurring in gem quality elsewhere, are not known in this condition in San Diego County:

Corundum. Aluminium oxide. Bull. 37, p. 45.

H. 9, G. 3.9–4.1. Luster adamantine to vitreous. Colors all prismatic hues to colorless.

The common varieties of this mineral are used as abrasives under the name emery. Transparent corundum ranks among the most valuable of gems and includes the ruby and sapphire. Ruby is red corundum. Sapphire includes all colors except red, but the name is more particularly applied to the blue colors. Mr. W. H. Trenchard reports light pink corundum from a locality 26 miles east of San Diego, on the north slope of Mt. San Miguel, 8 miles northeast of Sweetwater Dam, where it occurs in hydromica schist associated with garnet. He also reports bluish corundum from Tule Mountain north of Jacumba.

Dumortierite, Basic aluminium silicate, Bull. 37, p. 71.

H. 7. G. 3.265.

Five miles northeast of Dehesa and 1 mile south of Alpine Heights, on the line between Secs. 4 and 5, T. 16 S., R. 2 E., is a large body of quartz, enclosing crystals of dumortierite. When cut and polished this makes handsome specimens and would be available for ornamental work. Thus far no commercial use has been made of this material.

Graphic Granite. Bull. 37, p. 79.

This material consists of large masses of feldspar, in which are angular individuals of quartz, resembling Hebrew letters. It appears

in the pegmatite veins at Mesa Grande, Pala and elsewhere. When sufficiently solid and susceptible of polish it is available for ornamental work, boxes, vases, etc.

Labradorite. Lime—soda feldspar. Bull. 37, p. 80.

H. 6. G. 2.27. Colors, gray, brown, greenish.

The cleavable varieties show on their striated surfaces a beautiful play of colors like those of mother of pearl, caused by the phenomena of color interference. This mineral is reported from the gem mines but does not occur in especially good size or quality.

Vesuvianite. A Calcium-Aluminium Silicate. Bull. 37, p. 93.

H. 6.5. G. 3.35–3.45. Color brown to green.

This mineral in gem quality, is reported by W. H. Trenchard from Jacumba and San Vicente.

Axinite. A silicate of alumina, calcium and manganese, with some iron, and magnesia and also boric acid and water. Bull. 37, p. 96. Color, clove brown, plum blue, violet, pearl gray, honey yellow and greenish yellow.

In 1904 a discovery of this mineral was reported near Bonsall, 12 miles southwest of Pala, by Thos. A. Freeman. This was at the Moosa Canyon tourmaline locality.

Lazulite. Aluminium phosphate, with some magnesia and water.

H. 5.6. G.3. Color azure blue. Bull. 37, p. 98.

A specimen of this mineral was reported from the vicinity of Oceanside in 1893. State Mining Bureau Museum No. 13591. As there are no crystalline rock outcrops near Oceanside, this may have been drift or float material.

Epidote. Silicate of alumina, iron and lime, with some water. Color yellow-green, pistachio-green to red-gray and colorless. Bull. 37, p. 99.

H. 6–7. G. 3.2–5.

Found in clear transparent crystals at the McFall mine, 7½ miles southeast of Ramona. These were handsome crystals of gem quality.

Lepidolite. Lithia mica; Silicate of alumina and lithia with flourine and water. Bull. 37, p. 100.

H. 2.5–5. G. 2.84–3. Luster pearly. Color rose red, violet gray, lilac, yellowish, grayish, white, translucent. In rhombic crystals or granular massive.

The massive variety is used to some extent for ornaments such as ash trays, dishes, vases and paper weights. The chief deposit in this county is at Pala, in the Stewart vein.* In small quantities it occurs in all the veins at Pala and at Mesa Grande and at the Royal mine, southeast of Banner.

*(See Lithia Minerals, this Report, p. 76).

Chrysocolla. Hydrous copper silicate. Bull. 37, p. 101.

H. 2–4. G. 2–2.2. Color, various shades of green.

When occurring in masses of sufficient size, this mineral is cut for table tops and similar decorative purposes. In small masses it is used to some extent for jewelry. One specimen is in the State Mining Bureau Museum, locality not given. No. 7187.

Apatite. Calcium fluo-phosphate with some chlorine. Bull. 37, p. 102.

H. 5. G. 3.17–3.23. Color green to blue. Occasionally yellow, brown, red or gray.

Reported from Dos Cabezas mine, near Jacumba.

Fluorite. Calcium fluoride. Bull. 37, p. 102.

H. 4. G. 3.18. Luster vitreous. Color varied. White, yellow, green, blue, violet, crimson, rose, pink and brown.

This mineral, though rather soft, is often cut into paper weights, vases and other ornamental articles. It has been reported from the Mountain Lily mine on Aguanga Mountain.

Gold Quartz.

Bull. 37, pp. 68–9.

Auriferous quartz in which the gold occurs in conspicuous filaments and masses has long been used in certain forms of jewelry, such as brooches, links for watch chains, inlaying watch cases, etc. In the bonanza days of gold mining in this county, much of this material was found at mines near Julian, the Ready Relief in particular being quite productive.

ABRASIVES.

Under this head are properly included corundum or emery, quartz and garnet. The first, reported from the north side of Mt. San Miguel, is not in commercial quantities. Quartz, which is extensively used in the manufacture of sand paper, is found at many points in San Diego County, but there is not yet evidence of a sufficiently large market to justify the establishment of a factory and the material is not valuable enough to stand the expense of much transportation.

Garnet, which is used in making sandpaper for finishing wood and leather, is found in substantial quantity at the McFall mine, owned by John McFall, of Ramona, 7½ miles southeast of Ramona, on the east of the San Vicente Grant, SE. ¼ of Sec. 17, T. 13 S., R. 2. E. Here a shaft has been sunk 22 feet in solid garnet, which occurs in pockets in diorite.

Another deposit of massive garnet is in Sec. 25, T. 13 S., R. 8 E. Claims have been located on this by Bert Simmons, of El Cajon, and Homer Bailey, of San Diego.

Near Dos Cabezas Springs and within 1 mile of the San Diego and Arizona Railroad survey are a number of deposits of garnet suitable for abrasive purposes.

LITHIA MINERALS.

Bulletin 38, pages 306-10.

Lithia is used in commerce for medicinal purposes, in artificial mineral waters and in tablets. On account of its red flame the nitrate is used in making red fire.

This substance occurs in several minerals, the principal ones being lepidolite, amblygonite and spodumene. The first occurs in commercial quantities at Pala and in smaller amount at many points. The second occurs also at Pala, in small quantities, associated with the first. A rare variety of spodumene, called kunzite, also occurs at the same locality but as a gem mineral and not as a source of lithia.

Lepidolite, lithia mica, has a complex composition. The general formula given by Dana is $KLi[Al(OH,F)_2]Al(SiO_3)_3$. Analyses of specimens from different localities, show percentages of lithia ranging from 3.87 to 5.88. It occurs usually in scaly, granular masses, sometimes in aggregates of short six-sided prisims. The cleavage is basal, luster pearly, and the color rose-red, violet-gray and yellowish, or grayish white to white. Its hardness is 2.5 to 4, its specific gravity 2.8 to 2.9. It fuses easily to gray or white glass and colors the blow pipe flame red. It is distinguished from other micas by its fusibility by the red flame and by the reaction for fluorine.

Amblygonite is a fluophosphate of lithia and alumina, containing 10 per cent of lithia. It crystallizes in large coarse crystals in the triclinic system. Its hardness is 6, its specific gravity 3.01 to 3.09. The color is white to pale greenish, bluish, yellowish or brownish white. The Pala material is almost entirely white and to the eye closely resembles a feldspar, but it fuses easily in the blowpipe flame and tinges the latter red. Should the mineral be found in commercial quantity, it will be more valuable than the preceding, since it contains a larger percentage of lithia and the phosphoric acid is valuable as a by-product.

Spodumene, var. Kunzite, is a lithia alumina silicate, containing 8.4 per cent of lithia. It is found at Pala, but is not a commercial form of lithia. Its characters are given under the head of Gems.

As already stated under that head, these lithia minerals occur in San Diego County, on a northwesterly trending axis, parallel to the strike of the granite ranges and extending from the old Royal mine, southeast of Banner, through Mesa Grande to Pala.

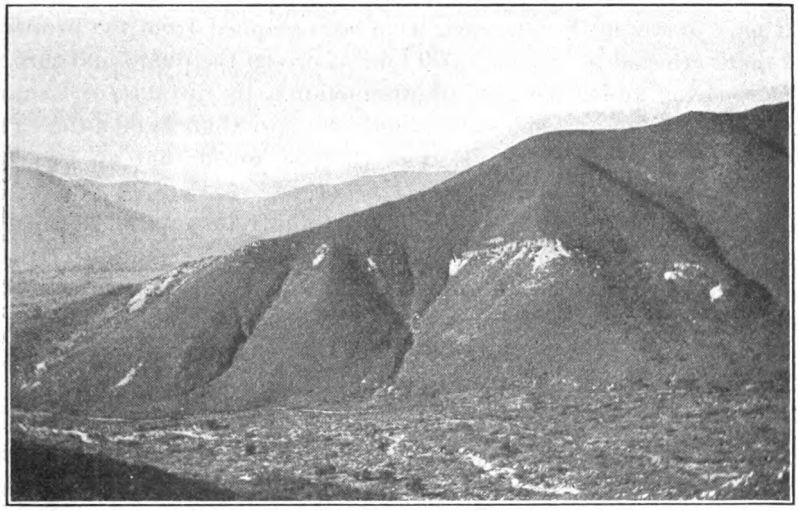
The Royal mine lies southeast of Banner on the southwest slope of Granite Mountain, in Sec. 18, T. 13 S., R. 5 E. Lepidolite occurs here in a pegmatite dike and, from all accounts, the quantity is quite limited.

The property, which has never been productive, is said to belong to Henry Blumenberg, Jr., of Los Angeles.

At Mesa Grande, lepidolite occurs in small masses, in the gem bearing veins on the San Diego, Himalaya, and Esmeralda properties. Commercially the quantities are insignificant. The Rincon locality is on the Pala axis, but lithia minerals have not been reported.

This widespread and persistent lithia mineralization culminates at Pala, where are the commercially important deposits of lepidolite and also those of the gem mineral kunzite.

Here as shown in the photograph on the east side of Tourmaline Queen Mountain, about 400 feet above the base, is exposed a great



Stewart Lithia Vein. Looking West from Pala Chief. F.J.H.M. Photo.

pegmatite dike 35 to 45 feet wide, and nearly horizontal in its main outcrop, which strikes about north 7° east and dips to the south about 5°. Westward the dike dips 10° to 15°. It is exposed for a length of 3,000 feet or more, from north to south, and has been opened at several points. Filling a fissure in this dike, somewhat below its central plane, is a vein of lepidolite from 15 to 20 feet thick. Throughout the lepidolite, radiating masses of rubellite or pink tourmaline occur abundantly and in occasional pockets are masses of amblygonite. As stated, the wider portion of the dike is above the lepidolite and the amblygonite, when found, was mostly in the lower part of the pegmatite above the lepidolite. About 30 tons of amblygonite were shipped from this mine and it is not known whether any substantial quantities remain. It was found mostly west of the ridge under which the dike passes. From each face of the hill, a tunnel was driven and, as they did not quite coincide

in level, they were connected by a short winze. The lepidolite was chiefly mined from the east tunnel and the ambylgonite from the west.

The principal portion of the lithia vein is controlled by the American Lithia and Chemical Company, 206 Broadway, New York City; Wm. N. Crane, president; Theo. Ludlum, secretary. This company owns the claims known as Mission and Stewart. Adjoining the latter to the north, is the Gem Lepidolite Mine, belonging to A. M. Labaugh, of Pala. The American Lithia and Chemical Company also owns a half interest in the Douglas claim on the small vein at the foot of the hill. The remaining interest is held by T. A. Blakeley, of San Bernardino.

While this Pala lepidolite deposit is of great size, its tonnage having been estimated at from 500,000 to 1,500,000 tons, the writer is informed that only 5 cars of 30 tons each have been shipped from the property, but there are said to be over 1,000 tons of ore on the dump and this has been reported under the head of production. Its distance of 28 miles from railroad, at Oceanside, should not add more than $4.00 a ton to the cost of production, and it is greatly to be hoped that an adequate market will soon be found.

Small masses of lepidolite are found in the veins of the Tourmaline Queen and Tourmaline King mines, on the same mountain. In the Pala Chief vein also, the lithia mica occurs in small quantities. It is also found in the gem bearing veins on Hiriart Mountain, but not in substantial tonnage.

PETROLEUM.

Petroleum of commercial interest has not yet been discovered in this county, although several wells have been and are being drilled and the operators of these seem quite hopeful of success. In several wells small amounts of gas have been encountered and occasional layers of sandy material, with suggestions of oil, have raised the hopes of the driller, but nowhere has oil been found in measurable quantity.

It is of interest to note that the middle Miocene beds which are the chief reservoirs of oil in the San Joaquin Valley and in Orange County, have not been identified in the county of San Diego, and the deepest wells in the latter have passed through all the Tertiary beds and the Cretaceous strata and have penetrated a black shale, sometimes calcareous, which is probably of Jurassic age. It is evident, therefore, that, if oil be found, it must occur in beds of different geologic horizon from those constituting the commercial oil reservoirs to the northward.* It would, perhaps, be unwise to say that it is impossible for oil in commercial quantities to be found in other horizons, in southern California but, thus far, we have no information that will justify the expectation that, in this region, it can be found in older strata than those yielding oil farther north.

*See Ralph Arnold, Bulletin Am. Inst. Min. Eng. March, 1914, pp. 406-11.

The chief encouragement to drill for oil in western San Diego County is stated to be the frequent occurrence, on the beaches, of masses of asphaltic residue or brea. The assumption is, that this material has come from submarine seepages and, from this idea, has sprung the hope that by drilling near the coast it might be possible to reach oil sands from which the inferential seepages may have come. In order to determine what evidence of seepage there might be in the waters near the San Diego coast line, a letter was addressed to Dr. Wm. E. Ritter, director of the Biological Station, near La Jolla, asking whether he knew of any submarine seepages. His reply is given herewith:

THE SCRIPPS INSTITUTION FOR BIOLOGICAL RESEARCH OF THE UNIVERSITY OF CALIFORNIA.

LA JOLLA, CALIFORNIA, November 18, 1913.

Mr. F. J. H. Merrill, Oceanside, Calif.

DEAR SIR: Replying to your letter of inquiry about petroleum in the ocean in this vicinity, I would say that we have seen no signs of it south of Redondo. It may be further stated, that our explorations of the sea over most of the continental shelf in this locality have been so extensive that, did outflows comparable with those in the Santa Barbara Channel exist here, they could hardly have escaped our notice.

Small fragments of asphaltum do occur, here and there, on shore rocks in many places, but I have always supposed they were brought from long distances—probably from the north.

Yours very truly,

WM. E. RITTER, Director.

In conclusion it may be said that while the search for petroleum in this region by persons with capital to spare for the investigation, is most laudable and evinces in a high degree the existence of a most cordial public spirit, it is not a matter to be undertaken by persons of limited means. As "twenty swallows do not make a summer," so a few bottles or even buckets of oil do not make a commercial oil field. The discovery here of a substantial oil field would be of incalculable value, but can not with certainty be anticipated.

Companies Drilling Oil Wells.

Lo Tengo Oil Company, 322 Timken Building, San Diego. President, A. J. Bradley; secretary, E. G. Dehm. Well one mile north of Tia Juana, NE. ¼ of NE. ¼ of SW. ¼, Sec. 31, T. 18 S., R. 1 W., 3,290 feet deep. Began 1911.

Tia Juana Valley Oil Company, 323 Timken Building, San Diego. President, A. C. Riordan; secretary, E. G. Dehm. Well 2½ miles south of Nestor. Lot 4, Sec. 9, T. 19 S., R. 2 W., 760 feet deep. Began 1910.

Otay Oil Company, American National Bank Building, San Diego. President, H. K. John; secretary, H. W. Archer. Well southeast of Otay, NE. ¼ Sec. 30, T. 18 S., R. 1 W. 2185 feet deep. Began 1910.

Balboa Oil Company, 629 Spreckels Theater Building, San Diego. President, A. J. Taylor; secretary-treasurer, John Wiseman. Well in Mission Valley, Pueblo Lot 1105, 3,352 feet deep. Began 1911.

San Elijo Oil Company, 554 McNeece Building, San Diego. President, J. McNeece; secretary, J. B. McNeece. Well southwest of Sorrento railroad station. Pueblo Lot 27, 1,700 feet deep.

Laura F. Clark Oil Company, formerly Panama-American Oil Company. President, Mrs. L. F. Clark, Encinitas. Well near La Costa. NE. ¼ of NW. ¼, Sec. 26, T. 12 S., R. 4 W. 2,265 feet deep.

Pacific Laguna Oil Company, President, A. R. Damarus, 217 Timken Building, San Diego; secretary, T. W. Dryden. Well near La Costa, SW. ¼ of SW. ¼ of Sec. 26, T. 12 S., R. 4 W. 1,400 feet deep.

The logs of the San Diego County oil wells are of much interest, but have not been kept with uniform precision and it is not easy to compare them. The drillers' descriptions are not always easy to understand geologically, but it is not difficult to note the conspicuous passage from the sands and the brownish clays of the Tertiary and Cretaceous, which we know at the surface, into gray, blue and black shales and calcareous beds, which probably belong in the Jurassic or Franciscan.

The log of the Balboa well is here given in full. That of Lo Tengo, which is also given, does not differ materially except that their surface heights being different, the changes in formation occur at different levels. These two and the Otay well appear to be the only ones which have penetrated into the hard formations below the Cretaceous.

The bottom of the San Elijo well is in the brown shale which is probably, in part, Cretaceous.

Wells of moderate depth have been drilled at Chula Vista, La Jolla and near Poway, but without finding oil.

Log of the Balboa Oil Well (1913).
Surface height, 15 feet.

	Thickness, feet	Depth, feet
Quicksand, gravel and shells	80	80
Sand and boulders	66	146
Shale blue and brown	179	325
Hard white shell lime	10	335
Water sand (artesian flow)	15	350
Shale blue and brown	150	500
Hard shell	10	510
Water sand	15	525
Shale mixed strata	175	700
Hard white shell lime	25	725
Water sand	175	900
Hot Water	100	1,000
Sand, shell and boulders	226	1,226
Sand and shale	74	1,300
Hard shell lime	25	1,325
Shale brown (clay stiff enough to stand up)	885	2,210
Hard blue lime	37	2,247
Water sand, blue shale	63	2,310
Blue black limestone gas? (new company began operations here)	100	2,410
Hard shell dark	144	2,554
Dark gray hard	5	2,559
Dark gray hard	12	2,571
Dark gray softer	4	2,575
Dark gray very hard	16	2,591
Dark gray softer	15	2,606
Dark gray hard	12	2,618
Dark gray softer	4	2,622
Light gray	15	2,637
Shell	9	2,646
Shale	4	2,650
Dark hard lime shell	22	2,672
	2	2,674
Blue shale	4	2,678
Dark hard line shell	16	2,694
Blue shale	3	2,697
Alternating shale and limestone	18	2,715
Blue lime	145	2,860
Blue shale	2	2,862
Dark blue lime	16	2,878
Hard blue lime	16	2,894
Dark blue lime	26	2,920
Light blue lime	22	2,942
Light blue lime mixed with white lime	5	2,947
Hard black slate and lime	3	2,950
Black slate	28	2,978
Blue black lime	7	2,985
Black slate	10	2,995
Gray sand rock	5	3,000

Log of the Lo Tengo Oil Well.
Surface height, 375 feet.

	Thickness, feet	Depth, feet
Sandy clay	20	
Sand and shale	20	40
Soft light yellow sand	200	240
Conglomerate	70	310
Hard shell	10	320
Soft red sand	37	357
Soft yellow sand	43	400
Blue shale	45	445
Soft sand and blue shale	50	495
Yellow clay	35	530
Yellow sand	42	572
Sticky clay	5	577
Blue clay	28	605
Gray sand	35	640
Blue clay	25	665
Blue clay	55	720
Blue shale	25	745
Sandy shale	50	795
Blue shale and clay	65	860
Light brown shale	505	1,365
Black sand	70	1,435
Brown shale	15	1,450
Black sand	37	1,487
Brown shale	15	1,502
Sand and conglomerate	38	1,540
Dark shale	55	1,595
Brown shale	20	1,615
Sand	15	1,630
Sticky blue clay	50	1,680
Blue shale	38	1,718
Red sand	17	1,735
Blue clay	208	1,943
Hard calcareous rock	472	2,415
Hard fine sand	40	2,455
Calcareous sand rock	27	2,582
Dark sand, gas	18	2,600
Calcareous rock	200	2,800
Conglomerate	32	32
Sand gas	13	45
Calcareous rock, gas and "oil"	20	65
Calcareous rock, soft sand and gas	35	2,900
Hard calcareous sand, "Good showing of oil"	65	65
Soft sand "oil"	20	85
Calcareous rock, soft sand layer "oil"	50	3,035
Hard calcareous rock with streaks of sand and some gas		

The Otay well is 2,100 feet deep. It is said hard rock was encountered at 900 feet. The surface height is about 400 feet.

COAL.

Lignite seams of limited thickness and extent have been reported from borings in the vicinity of San Diego, and tradition says that some thirty years ago a bed of coal exposed at low-water mark, in the beach near Del Mar, was worked as a source of fuel for blacksmith forges.

At the present time, with oil as a cheap and abundant fuel, there is no inducement to investigate or search for these small coal beds.

GRAPHITE.

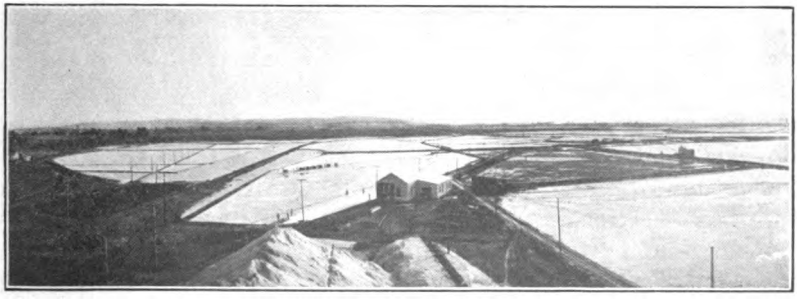
This important form of carbon is much used for making pencils, for lubricant and for crucibles for foundry facings, for stone polish and for paint. But little has been found in this county. The chief occurrence is reported from near Mason's on the road from San Felipe to Carrizo Creek. As reported by Frank Stephens, of Julian, the graphite occurs in mica shist and the deposit is in Sec. 10, T. 14 S., R. 5 E. It belongs to Mr. Stephens and Thos. L. Works, of San Diego.

Other outcrops of graphite bearing material, are known in the same region.

SALT.

Bulletin 24.

There is no source of salt in San Diego County, except the water of the Pacific Ocean, from which it has been extracted at various points on the coast by solar evaporation. At the present time there are but two

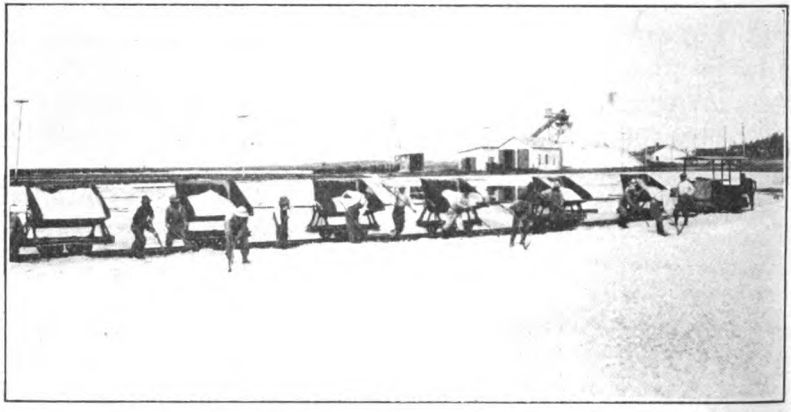


Western Salt Company's Plant. General View.

plants in operation in the county, both of them near San Diego. They are operated respectively by the Western Salt Company and J. P. Duncan's Sons.

The Western Salt Company is not incorporated. Mr. E. S. Babcock is the chief owner of the enterprise. The plant is situated in the south end of San Diego Bay, the railroad station being called Fairfield. The holdings comprise about 900 acres of tide marsh, which by dredging and

the building of dikes has been laid out in a series of inter-communicating ponds of slight depth. The six largest ponds adjacent to the bay are known as the tide ponds. During high tides, which occur about twice a month, these are filled with water from the bay which flows in at a strength of twelve to fifteen salinometer degrees and is retained by flood gates. The density in San Diego Bay is said to be greater than that of the water of San Francisco Bay. After staying in the tide ponds a short time the water is moved by pumps into the secondary ponds which are smaller and shallower, and greater in number. Here it again remains and is strengthened by solar evaporation and is transferred by gravity into the lime of pickle ponds, at this time having a density of about sixty-six degrees of the salinometer. In the pickle

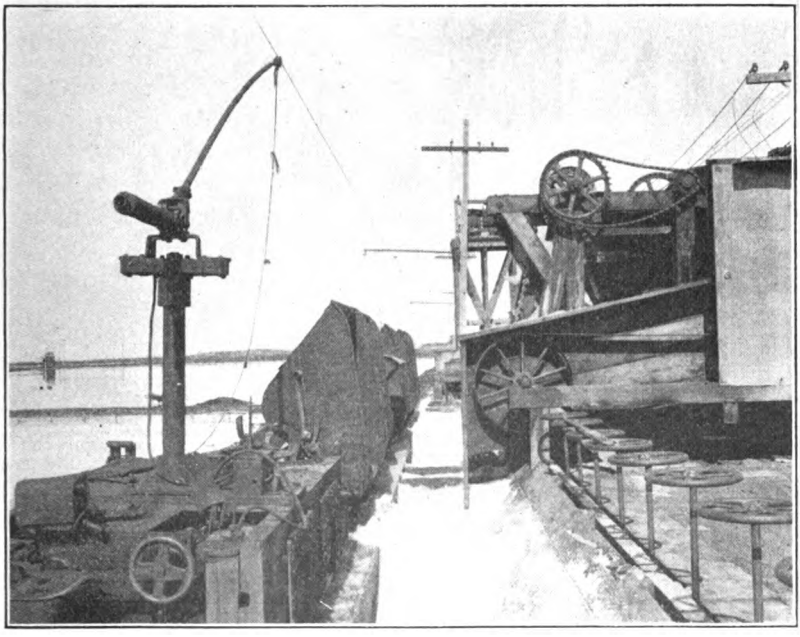


Western Salt Co. Harvesting.

ponds the brine reaches a strength of one hundred salinometer degrees or a specific gravity of 1.201, by which time the gypsum, magnesia salts and other foreign matter have been deposited so that when moved from the pickle ponds into the crystallizing ponds it is freed from all objectionable impurities. In these crystallizing ponds, of which there are fifteen, when a specific gravity of 1.215 is reached, the salt begins to crystalize out, and at 1.235 to 1.252 specific gravity, salt of the first quality is deposited, after which the remaining brine, known as bittern water, is pumped off and allowed to seep into a part of the marsh. As the bittern water is withdrawn, new brine is transferred from the pickle ponds into the crystallizing ponds and thus the process continues until the salt deposit has reached a depth of eight or ten inches. This is considered a practical maximum, since if a greater depth is permitted to form, it becomes so compact that it takes an excessive amount of labor to break it up. A depth of nine inches is estimated to yield 1,800 tons per acre.

When the desired thickness of salt has been deposited the pond is drained and a crew of men is set to work to harvest the salt. Movable tracks are laid on the bottom of the pond and small dump cars, similar to ore cars, moved by gasoline locomotives, are used to receive the salt which is loaded by shoveling. From the pond where the salt is harvested the loaded cars are transferred to a small electric railway which runs along the crystallizing ponds, and thence go to the washing plant, where the salt is raised by a bucket conveyor and distributed into piles.

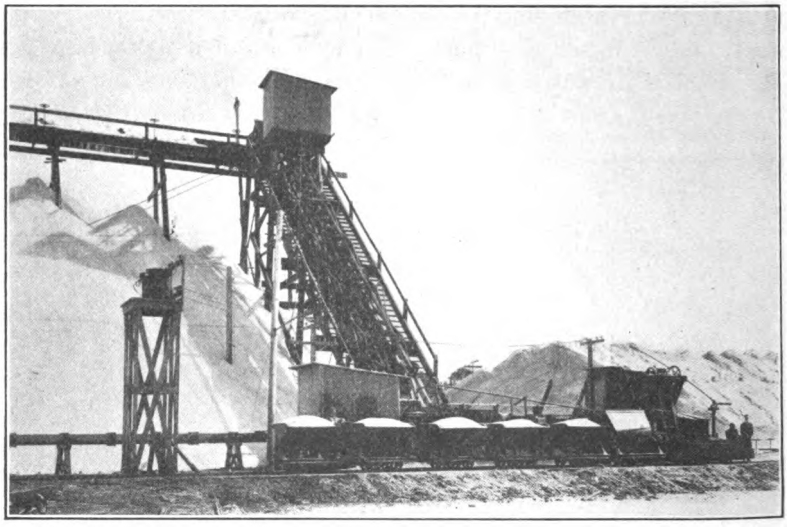
The methods of washing and elevating are ingenious and effective. From the cars the salt is dumped into a trough, at the bottom of which



Western Salt Co. Salt Washing Equipment.

is a screw conveyor. This carries the salt to a small bucket conveyor, which lifts it a few feet up into a washing trough. Here, as the salt is moved along by a screw conveyor, it is washed by a current of saturated brine flowing in the opposite direction. From this washing trough, the salt is raised by a conveyor having buckets made of wire mesh. These successively pass under a stream of brine, which washes out any remnant of foreign matter which may be adhering to the salt. During the ascent, a final washing is given with a spray of fresh water. This conveyor raises the purified product to the top of a trestle about a hundred feet high and discharges it into a long trough through which, by screw conveyors, it is transported to be dumped at convenient points in storage piles to await the demand of the market.

The present production is about 15,000 tons and arrangements have been made to increase this to nearly 40,000 tons during the next year. The harvest season begins about September 1st and lasts through about three months. The salt is used for curing fish and hides, shipments being made as far north as Alaska for the former purpose. It is also



Western Salt Co. Salt Stacker.

used in the manufacture of ice cream and in various forms of business in which coarse salt is used. The following analyses show its composition and purity:

STAUFFER CHEMICAL COMPANY.
Laboratories.

San Francisco, Cal., October 30, 1912.

Constituents determined	Per cent			
	No. 1 Old salt unwashed	No. 2 Old salt washed	No. 3 New salt unwashed	No. 4 New salt washed
DRY SALT.				
Insoluble in water	.084	.050	.044	.054
WATER SOLUBLE.				
Calcium sulphate	.224	.203	.202	.179
Calcium chloride	.194	.050	.186	.046
Magnesium chloride) Magnesium sulphate)	.606	.296	.331	.215
Sodium sulphate	.350	.121	.317	.110
Undetermined	.087	.071	.065	.079
Sodium chloride	98.455	99.209	98.855	99.317
(Including small amount of potassium chloride, and iron and aluminium sulphate)	Trace	Trace	Trace	Trace

E. C. MISSBACH, Analyst.

The Chollas Valley Salt Company, controlled by J. P. Duncan, 1420 National avenue, San Diego, has a small plant. Its production amounts to 600 to 700 tons yearly.

PHOSPHATES.

Minerals containing phosphoric acid are in demand as a source of this material for fertilizer, but no deposits of commercial importance have yet been found in San Diego County. Two occurrences have, thus far, been reported. One is said to be apatite, in crystalline limestone, near the Grapevine camp in Sec. 26, T. 11 S., R. 4 E. This was, at one time, controlled by David McGregor, of the Montezuma Mining Company.

Another is a deposit of white calcareous material forming a layer or stratum in the mesa east of Otay. This shows, on analysis, less than 2 per cent of phosphoric acid and is, therefore, not available commercially. Apatite, in limestone, is also reported from the vicinity of Jacumba.

WATER.

This is probably the most important of all minerals. Raised from the ocean by evaporation, transported in the clouds and fogs and precipitated by fall of temperature, water deserves the greatest attention and the most energetic form of conservation.

In San Diego County, the chief rainfall is on the west slope of the divide and, in the mountains, averages 30 inches per year. Taking into consideration the fact that a substantial percentage of this area is stony and unfit for agriculture, we see that, if conserved, the run off from the western slope should be ample to irrigate all the arable land.

For details of rainfall, the reader is referred to the records of the U. S. Weather Bureau and for measurements of stream flow to Water Supply Paper No. 300, U. S. Geol. Survey.

MINERAL WATERS.

A number of mineral springs have long been known in this county, some of them having a high reputation as curative agents. For some years the annual production and sale of bottled water has been considerable, but of late, it has declined, possibly through the increasing out-of-doors habit of living, which has come with the development of the automobile. The principal springs are here enumerated.

The Coronado Spring.

This spring is southwest of Otay, in Sec. 22, T. 18 S., R. 2 W. An analysis by C. Gilbert Wheeler gives the following composition:

Analysis	Grains per gallon
Sodium chloride	10.168
Potassium chloride	.912
Potassium sulphate	.552
Magnesia sulphate	4.728
Calcium carbonate	6.488
Calcium sulphate	1.328
Peroxide of iron	.040
Silica	1.080
Organic	.992
Total solids per gallon	26.288

This water is not, at present, in commercial use.

Nuvida Mineral Spring.

This spring, about 10 miles east of San Diego and formerly known as Isham's Spring, is in the Jamacho Grant, north of the Sweetwater Reservoir. It is owned by W. Freeland Kendrick, 8 South Eighteenth street, Philadelphia. W. C. Sherman, of Spring Valley, is the local manager. During the past year no water has been placed on the market.

Analysis	Grains per gallon
Sodium chloride	16.32
Potassium chloride	1.98
Magnesium chloride	10.10
Calcium chloride	2.93
Calcium carbonate	11.19
Magnesium sulphate	3.48
Iron peroxide	.03
Manganese carbonate	.17
Silica	3.09
Alumina	.09
Total solids per gallon	49.75

A mineral spring belonging to F. W. Bradley, of San Diego, is about 4 miles north of Foster in Sec. 12, T. 14 S., R. 1 W. No analysis is available, but the solid contents are given at 8 grains per gallon of which 5 grains are sodium chloride.

El Granito Mineral Springs Company.

Manager, C. C. Goldsberry. Main Office, 1015 Twenty-first street, San Diego. Branch Office, 1065 Second street, San Diego.

These springs are owned by William H. Fisher and are about a mile southeast of El Cajon, in 70 acres of the El Cajon Grant, described as the SW. ¼ of SW ¼ and E. ½ of NW. ¼ of SW. ¼, Sec. 14, T. 16 S., R. 1 W.

The curative properties of these waters in regulating the digestive functions have been known from earliest times and were greatly valued by the Indians.

Analysis.

By Joseph Luce, Salt Lake City.

U. S. gallon of 231 cubic inches contains—

	Grains
Sodium chloride	2.448
Potassium carbonate	6.810
Sodium bicarbonate	14.164
Sodium carbonate	7.390
Potassium sulphate	.168
Magnesium sulphate	16.873
Aluminum oxide	.540
Calcium oxide	.392
Iron oxide	Trace
Silicium oxide	.927
Carbonic acid (free)	2.216
Organic matter	Trace
Total	51.928

The company is equipped with a bottling plant in operation since June, 1913. The monthly output is from 800 to 1,000 gallons.

Warner's Hot Springs.

These springs, long known to the natives as Las Aguas Calientes, are situated at the northeastern margin of the old grant, known as San Jose del Valle, and by county highway are about 67.6 miles from San Diego.

The property is controlled by a syndicate which conducts a hotel and sanitarium on the property. Manager, F. S. Sandford. The postoffice is known as Warner Springs. The temperature of the water is stated at 148° F. and the analysis is given as follows:

	Grains per U. S. gallon
Sodium sulphate	5.65
Sodium sulphide	3.53
Silica	3.44
Sodium silicate	2.64
Sodium carbonate	2.63
Sodium	2.39
Potassium sulphate	0.43
Calcium silicate	0.38
Calcium phosphate	0.11
Ammonium	0.09
Magnesium sulphate	0.09
Sodium biborate	0.09
Ferric oxide	0.04
Lithium	Trace
Strontium	Trace
Magnesium oxide	Trace

Buckman Springs.

Buckman Springs Mineral Water Company, 515-516 Union Building, San Diego. President, Geo. W. Walker; secretary, T. B. Cosgrove. These springs are about 60 miles east of San Diego in Sec. 20, T. 16 S., R. 5 E. The company has recently bought the springs and hotel with 160 acres of land. The water is bottled, charged with natural gas and shipped in large quantities, being recommended for rheumatism and similar ailments. An analysis by Smith, Emery & Co. follows:

	Grains per U. S. gallon
Silica (SiO_2)	5.55
Alumina (Al_2O_3)	0.43
Iron bicarbonate ($Fe(HCO_3)_2$)	2.45
Calcium bicarbonate ($Ca(HCO_3)_2$)	61.90
Magnesium bicarbonate ($Mg(HCO_3)_2$)	10.18
Magnesium sulphate ($Mg\,SO_4$)	4.75
Calcium sulphate ($Ca\,SO_4$)	0.86
Magnesium chloride ($Mg\,Cl_2$)	2.09
Manganese perchloride ($Mn\,Cl_4$)	Trace
Potassium chloride ($K\,Cl$)	1.21
Lithium chloride ($Li\,Cl$)	14.93
Sodium chloride ($Na\,Cl$)	47.65
Sodium nitrite ($Na\,NO_2$)	Trace
Sodium bicarbonate ($Na\,HCO_3$)	6.03
Total solids per gallon	158.03

	Parts per million
Free ammonia (NH_3)	0.082
Albumenoid ammonia (NH_3)	0.086
Oxygen absorption	1.400
Free carbonic acid gas (CO_2)	730.5
Free carbonic acid gas (CO_2), expressed in cubic centimeters per liter, 0°Cent. and 760 m. m. pressure	371.7

On the old ranch known as Corral de Luz, lying just north of the Sta. Margarita Grant, about 18 miles northeast of Oceanside, there are said to be several mineral springs, but no analyses are on record.

At Jacumba are warm springs of medicinal properties and baths for visitors have long been established here. (See under the next head.)

Desert Springs and Wells.

In the desert areas, springs of potable water are of much importance, both to the traveler and to those who endeavor to develop or operate mines. Inasmuch as many years must elapse before sufficient capital can be invested to reclaim and utilize all the desert areas in this part of California, it will be useful to give here a list of the desert springs. The following information is chiefly taken from U. S. G. S. Water Supply Paper No. 224, prepared in 1908 by W. C. Mendenhall, mainly from data furnished by Professor Gilbert E. Bailey, who some years ago prepared for the State Mining Bureau, Bulletin No. 24 on the Saline deposits of California. It is not improbable that in the six years which have elapsed some local changes may have occurred.

"*Clark Well.*—This is in Sec. 8, T. 9 S., R. 6 E., near the northeast end of Clark Dry Lake, at an elevation of 555 feet.* Trails lead to it from Rock House Canyon on the northwest and from Coyote Creek Valley, and a little used wagon road connects near Borrego Spring with the road from Seventeen Palms Springs to Julian. The well can easily be found from its position north of the dry lake. The water is good.

"*Borrego Spring.*—This is in Sec. 17, T. 11 S., R. 7 E., on the west bank of the broad Borrego Wash, at an elevation of 452 feet. It is about 33 miles by wagon road from Julian. The water of this spring, although somewhat alkaline, is entirely usable. Mesquite trees grow near the spring and in the valley, and salt grass, willow, and rushes are abundant. An old cabin stands on the bank about 50 feet from the spring and serves to mark its position.

"*Seventeen Palms Springs.*—These springs lie in Sec. 35, T. 10 S., R. 8 E., at an elevation of 410 feet, near the junction of three washes in the clay hills, south of the Santa Rosa Mountains. At present only eight or nine palm trees stand near them, the remainder of the seven-

*See Indio Quadrangle, U. S. G. S. The section, township and range numbers are supplied by the present writer.

teen, from which the springs were named, having been destroyed by fire. The springs are about 12 miles by wagon road east from Borrego Spring, or 45 miles from Julian, but the road is little used, is dim, and may be difficult to follow, particularly after the winter rains. Broken clay hills and deep washes surround the springs. Grass and wood in small quantities may be found near them. When they are kept open the water is fairly good, but it becomes bitter and bad by neglect and disuse. The soil is impregnated with alkaline salts.

"*Vallecito Springs.*—Vallecito Springs are in the valley of Vallecito Creek, Sec. 11, T. 14 S., R. 6 E., about 33 miles east of Julian, on the road to Carrizo station, at an elevation of about 1,600 feet. The old adobe stage station, in use when this road was a transcontinental stage route, still stands and is in fairly good condition. A watering trough stands near the building, and there are mesquite and cottonwood trees in the vicinity. The quality of the water is fair.

"*Hanna Well.*—This well is approximately in Sec. 36, T. 13 S., R. 8 E., at the base of the north slope of Black or Fish Creek Mountain, 15 or 18 miles southeast of Borrego Spring, and 10 or 12 miles southwest of Harper (or Mesquite) Well. It is not on a main road, but is near the mouth of a canyon heading in a pass that leads to the valley of Carrizo Creek. The water is good.

"*Agua Caliente Springs.*—About 3¾ miles eastward from Vallecito Springs and about ¾ of a mile southeast of the wagon road between Julian and Carrizo station there are several springs in a natural amphitheater comprising an area of about 50 acres. The water is tepid and impregnated with sulphur, but is not unpleasant to the taste. The combined flow of the springs makes a rather large stream. Grass and wood are scarce.

"*Mountain Palm Springs.*—These are in Sec. 12, T. 15 S., R. 7 E., at the foot of a high, broken rocky ridge and are several miles south of the main wagon road across the Sierra Madre, but can be easily reached by a side road that was made a few years ago. The water is cool and fairly good. Wild palms and other vegetation make the vicinity inviting.

"*Palm Springs.*—There are several palm springs in San Diego County, but those here referred to are about 9 miles east of Vallecito Springs, just north of the line between Secs. 25 and 36, T. 14 S., R. 7 E. The palms that gave the springs their name were destroyed long ago, but there are several mesquite trees near by. The springs are situated under a clay bank, and digging is sometimes necessary in order to obtain water. The water has a temperature of about 60° and is somewhat sulphurous.

"*Mason Ranch.*—Mason Ranch is in Sec. 1, T. 14 S., R. 5 E., on the road from Carrizo Creek to Julian and Agua Caliente (Warner's Hot

Springs). This is the principal road through this part of the desert, and may easily be followed. At the ranch an excellent supply of water has been developed.

"*Carrizo Station.*—This Station, Sec. 12, T. 15 S., R. 8 E. (elevation 450 feet), is near the left bank of Carrizo Creek wash, about 9 miles east of Palm Springs, on the main road from Julian to the Imperial Valley. There are a number of springs near the station, and two of them furnish fairly good water. There is also a rather large tule swamp around the station, from which a strong stream of alkaline water flows. Rough clay hills of late Tertiary age, showing typical bad-land erosional forms, are prominent features of this region. Carrizo was originally a stage station on the old line to Yuma, but the adobe buildings are now very dilapidated, their ruin having been completed by the earthquake of February, 1892.

"*Mountain Springs.*—These springs, in Sec. 24, T. 17 S., R. 8 E., are about 9 miles by road from Jacumba Springs and 33 miles from Campo, at an elevation of about 2,500 feet. Forty years ago there was a stage station here, on the Butterfield stage line from San Diego to Yuma. The ruins of the old stone corral and buildings are still visible. Water issues from the side of a rocky ravine and a portion of it is carried in an inch pipe about 200 feet to a trough beside the road. The quality is excellent.

"From Mountain Springs the road to El Centro passes through a rocky gorge in which water can be found a portion of the year.

"*Jacumba Springs.*—These are about 24 miles east of Campo, on the line between Secs. 7 and 8, T. 18 S., R. 8 E., and about ¼ mile north of Monument No. 233 of the international boundary, at an elevation of about 2,825 feet. They are all on the west side of the long, open valley of Carrizo Creek, whose outlet is to the northeast, through a deep narrow gorge, of which the greater part, including its head, is in Mexico. The springs include one of cold water and several that yield waters with temperature ranging from 86° to 98° Fahrenheit. These thermal waters are regarded as medicinal, and a bath house and other accommodations are provided for travelers."

The two foregoing groups of springs are on the automobile stage route from San Diego to El Centro, Imperial County.

CHAPTER II.

IMPERIAL COUNTY.

HISTORY.

This county formed part of San Diego County from the organization of the latter in 1851 to August, 1907, when it was separated and formed into a separate county by vote of the supervisors of San Diego County under an act of legislature giving them that power.

PHYSIOGRAPHY.

The most important feature of Imperial County is the broad and nearly level expanse of the Colorado River Delta which separates the Gulf of California from the Salton Basin and is generally known as the Imperial Valley. This basin lies in a synclinal valley bordering on the east the anticlinorium of the lofty granite ranges of San Diego and Riverside counties. Several small ranges of volcanics, metamorphic palæozic rocks and uplifted Tertiary beds, interrupt the general level of the delta plain and, on its eastern margin, is an extensive hilly area of volcanic rocks which continues eastward into Arizona. The great granite masses of San Diego County, barely appear east of the boundary line.

GEOLOGY.

In its general geology, Imperial County is closely linked with San Diego and, under that head, will be found a synopsis of the more important geological features. The chief item that is distinct is the history of the Salton Basin.

It appears that, in Tertiary time, this basin was the northern end of the Gulf of California, which extended some 160 miles farther north than at present, and extensive marine deposits were laid down, as shown by the marine Miocene fossils associated with the clays on its western margin. This condition of submergence probably continued after the close of the Tertiary and later, as the Pleistocene uplift of about 1,000 feet above present sea level which occurred on the Pacific coast of California probably involved this valley, a large part of the Tertiary Gulf of California became dry land. With the succeeding subsidence came another marine occupation of the valley. In the meantime, the delta deposits of the Colorado River, which debouched into this basin near Yuma, gradually increased in extent and altitude until they formed a natural dam of great width, isolating, from its connection with the gulf, that portion of the basin north of the present area of settlement. The Salton Basin was then occupied by a salt lake which, in that arid climate, was gradually dessicated and finally became dry, leaving behind large deposits of salt. From that time on, Salton Basin was alternately dry and flooded by the waters of the

Colorado as, from time to time, the river found its outlet toward the gulf or toward the north.*

The local Indian tribes have various traditions of the presence of a great lake in the valley and its existence is proven by the presence of great numbers of fresh and brackish water shells, which gave to the northern part of the basin, in Mexican times, the name of the Conchilla Valley, barbarized by later inhabitants into Coachella. There is, also, substantial evidence of this lake in the old beach line which has been traced around the basin at an altitude of about 40 feet above sea level.[1]

For this prehistoric body of water the name of Lake Cahuilla was proposed by its discoverer, Prof. W. P. Blake.†

The earliest inundation after the American occupation of the region occurred about 1849. The lake of that period also dried up and the Salton desert was without water until June, 1891, when another overflow of the Colorado River produced a lake 30 miles long and 10 miles in width.[2] This, in time, gradually evaporated and became much reduced in area, but in 1904, through the careless opening of the north dike or levee, in connection with the irrigation of the Imperial Valley, the river was again released and the Salton Basin was flooded and the submergence rapidly increased, doing great damage, until the Southern Pacific Railway Company, under presidential authority, closed the gap in February, 1907.

MINERAL RESOURCES.

While of no great variety in its mineral resources, Imperial County is not deficient in natural wealth as, apart from its great agricultural possibilities, its deposits of crystalline limestone and clay promise a great supply of building material which should make it a center of production for a very large area. Its production of metals also, may be important in the near future.

In the following pages these resources are briefly outlined.

GOLD.

The gold deposits of this county are in the southeastern corner, occurring in ranges with northwest trend, between the line of the Southern Pacific Railway and the Colorado River. They are also in the northwest extension of the famous gold belt of the Altar District of Sonora, Mexico. The persistence of this zone in direction, through a distance of many miles, is very marked, though it is not a zone of continuous mineralization. In Mexico the auriferous areas are separated by barren spaces, sometimes miles in extent, the precious metal being confined to metamorphic and sedimentary formations and not found in the

*See further U. S. G. S. Water Supply Paper No. 225, by W. C. Mendenhall, pp.17–20. Also U. S. G. S. Water Supply No. 300, by H. D. McGlashan and H. J. Dean, pp.29–33.
†Nat. Geogr. Mag., Vol. 18, p. 830.
[1]Wm. P. Blake, Pacific Railroad Reports, Vol. V, 1853.
[2]E. B. Preston, R. XI, pp. 387–393.

granites which underlie them. This fact suggests that the latter are younger than the period of metallization.

Of the ranges mentioned, that known as the Cargo Muchacho Range, in which are the Golden Cross, the American Girl, the old Cargo Muchacho mine and others, is of metamorphic gneiss and schist cut by pegmatite dikes, and lies 3 to 4 miles northeast of the line of the Southern Pacific Railway, its southeastern extremity being about 9 miles from Yuma. Along its major axis, which trends northwest, it measures about 9 miles and in a transverse direction about 5 miles. This range is surrounded by a gentle sloping plain or mesa and is divided into two nearly equal portions by a deep canyon trending southwesterly. In the northern section, sometimes called the Hedges Mountains, of which the summit measures 2,225 feet, are the Golden Cross mines and, in the southern section, of which the chief peak rises 2,130 feet, are the American Girl and the old Cargo Muchacho mine and others. In the various peaks and ridges, many auriferous veins have been found, and in all the gulches of the range and the washes leading from them, placer gold has been abundant. Northeast of this range, the plain or mesa, has an altitude of 750 to 900 feet and a width of some 4 miles, being succeeded toward the Colorado River by the mountains of the Picacho district, of which the chief summit, El Picacho, attains a height of 1,945 feet.

The Picacho hills, over an area of perhaps 100 square miles, are chiefly of volcanic lavas, tufas and conglomerates, but as shown in the deeply eroded areas, the volcanics are underlain by metamorphic schists and gneisses of various types which contain the chief gold deposits and may be equivalent in age to those of the Cargo Muchacho Range. The topographic features of this area are shown in detail on the U. S. Geological Survey topographic sheet known as the Yuma Quadrangle, as well as the position of the Golden Cross and American Girl mines.

Cargo Muchacho Range.

R. XIII, p. 333.

While the presence of gold in this region had been known from early times and had been the basis of dry placer mining on a small scale, it was not until after the completion of the Southern Pacific Railway to Yuma in 1877, that much underground mining was done. In 1878–79, a 20-stamp custom mill was built on the river about 6 miles below Yuma at the place called El Rio by Gillespie and Childs, under the name of the Yuma Mill and Mining Company. Here ore was treated, at first from the Cargo Muchacho mine and afterwards from the Golden Cross. The latter, having been the most productive of the properties in this district, will be described first:

The Golden Cross Mines.

R. XII, p. 240. R. XIII, p. 337.

In a re-entrant of the west margin of the Cargo Muchacho range, is the mining camp formerly known as Hedges, but rechristened Tumco by the United Mines Company, from the corporation title of which the abbreviated name is formed. Here is the group of mines known as the Golden Cross, from the former name of one of the claims, now relocated as the Missouri.

The original claim was located in 1884 by one Peter Walters, under the name of Little Mary. Soon, other claims were located and changed owners several times until, in 1893, the properties were taken over by the Golden Cross Mining and Milling Company. This was succeeded in

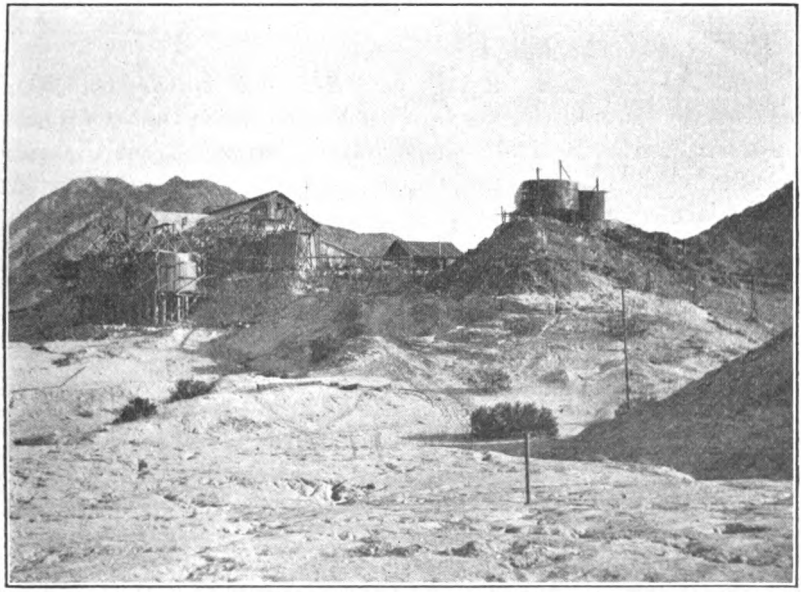
Pegmatite Dikes in Schist, Tumco. F.J.H.M. Photo.

1897, by the Free Gold Mining and Milling Company, which in turn was superseded in 1910 by the United Mines Company, Dr. Milbank Johnson, President, 1215 Marsh-Strong Building, and D. S. Cook, Secretary, 805 Central Building, Los Angeles.

At Tumco, the prevailing formation is a micaceous quartz schist, in part feldspathic, weathering brown on the surface and cut, in all possible directions, by a myriad of pegmatite dikes, varying from a few inches to a few feet in width. Undoubtedly, to these dikes the range owes, in great measure, its preservation from the erosion which has removed from view the larger portion of this formation formerly exposed above sea level.

The ore bodies at Tumco are in quartzose schist or gneiss, probably a metamorphosed arkose, and the mineralization parallels the stratifica-

tion in certain layers of the schist. The mineralized beds dip about 30° southeast with a strike of north 34° east. In the past a very substantial thickness of the rock, from 15 to 25 feet, has been mined as ore, but some of this was of very low grade. The country is extensively faulted and at least two systems of faults exist. One of these, a major system, trends nearly northeast and southwest and the minor system has a trend nearly at right angles to this or a little east of south. There are three shafts and groups of workings in the camp known as Golden Queen, Golden Crown and Golden Cross. The two last are believed to be in the same stratum. The Golden Queen, which is 1,000 feet deep on the incline, is in a monoclinal fault block, north of that which contains the other two and it is probable that the two ore bearing strata were once



The Golden Cross Mill, Tumco. F.J.H.M. Photo.

continuous, faulting in the major system having displaced and cut off the Golden Queen block from that containing the others. The property is now under very careful and conservative management, being under bond to Seeley W. Mudd of Los Angeles, and keen ability is being directed to the discovery of ore beyond the secondary fault planes and to the development of the old ore bodies already opened. At the moment all work is being done on the Golden Cross. Here the shaft measures 1,200 feet on the incline. The Golden Crown is 1,100 feet deep on the incline.

The property is well equipped with a 100-stamp mill, which has

recently been fitted with a tube mill. The equipment in detail was as follows, in December, 1913.

One No. 5 Gates rock crusher;
One Robbins 18-inch conveyor with distributor over battery bins;
50 stamps equipped, but 20 running at present;
One 22′ by 5′ tube mill;
Two Akins classifiers;
One Dorr classifier;
Two 10″ by 54″ Frenier sand pump;
One Dorr thickener 36 by 12′;
Two Trent replacers 24 by 16′;
One air lift agitator 24 by 16′;
Two Trent replacers 25 by 16′;
Two special replacers 24 by 16′.

With necessary sump tanks, zinc boxes, etc. No amalgamation or concentration is used. Cyanide solution is added in the stamp battery. All slime product is treated by agitation and the Trent replacement process.

The Golden Cross group has been a noted producer of gold in the recent past, the production having amounted to several millions of dollars. The operations of Mr. Seeley W. Mudd were discontinued in September, 1914.

American Girl.

R. XIII, p. 331. Register Mines and Minerals, 1902.

This property about 5 miles northeast of Ogilby and 3 miles southeast of Tumco, was extensively worked some fifteen years ago. It is now controlled by the Imperial Reduction Company of Pasadena, R. Schiffman, president; MacD. Snowball, secretary; C. Terry DuRell, general manager.

The geological conditions are very similar to those at Tumco. The ore is quartzose vein matter and silicified country rock, carrying iron pyrites which contain the gold. The development work on the property was described in the Register of Mines and Minerals in 1902, as being 1,000 feet deep on the incline and no mining has been done for some years, but the mill has been newly equipped for the resumption of operations. The treatment will be by grinding in Hardinge mills, removing the slime to cyanide tanks and passing the sands over Richards classifiers from which they will go to Deister tables for concentration. The concentrates will be shipped and the slimes will be cyanided by the Trent replacement process.

Since the writer's visit, mining and milling have commenced at the rate of about 75 tons per day.

A cloudburst during the second week in November, 1914, flooded the lower workings and it is estimated that 4 months will be required to unwater the mine and open the shaft. (Min. and Sci. Press, Nov. 28, 1914, pp. 855–6.)

In addition to the two active properties above described, there are several others in this district of which some have scarcely been opened, while others have been worked and abandoned years ago. The following is a list of these properties:

Name	Location	Owner
Delta	Adjoining Golden Cross on the northwest	Thos. Johnston, Ogilby, Cal.
Banner Group, 6 claims	Adjoining Golden Cross on east	Larry Wren, Ogilby, Cal.
Mayata Englewood	Adjoining American Girl on west	Thos. Johnston, Ogilby, Cal.
Yuma		H. Randolph, Ogilby, Cal.
Arizona	Adjoining American Girl on east	J. Ernest, Los Angeles, Cal.

The foregoing six properties have never been producers but the following in years past have been productive. At this date there is nothing to be stated except the details of their history and so the reader is referred to Reports XI, XII and XIII and to the Register of Mines and Minerals of San Diego County.

Pasadena and southern extension or Mother Lode, 1 mile northeast of American Girl; $\frac{2}{5}$, Wm. Borthwick, Ogilby, Cal., $\frac{2}{5}$, P. B. Mathiason, St. Louis, Mo., $\frac{1}{5}$, Mrs. Irene Grimes, Pasadena, Cal. R. XI, p. 386. R. XII, p. 242. R. XIII, pp. 341, 343.

Guadalupe, $1\frac{1}{2}$ miles northeast of American Girl; owner not known.

Blossom, 3 claims, 1 mile southwest of American Girl; John McEwan, Ogilby, Cal. R. XII, p. 238. R. XIII, p. 333. R. M. & M., p. 6.

Padre y Madre, adjoining Blossom on southeast; Mrs. S. B. Wright, San Bernardino, Cal. R. XII, p. 242. R. XIII, p. 343. R. M. & M., p. 6.

Cargo Muchacho (Pat.), $1\frac{1}{2}$ miles southeast of Blossom. R. VI (Pt. 1), p. 81. R. XI, p. 385. R. XII, p. 239. R. XIII, pp. 333–4. R. M. & M., p. 6. Owner not known.

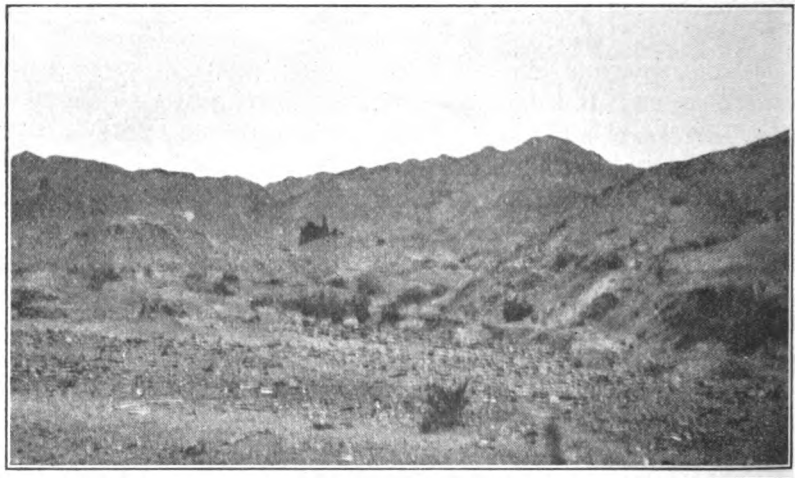
PICACHO.

This district, which lies near the Colorado River in T. 13 and 14 S., R. 22 and 23 E., has long been a seat of operations in vein and placer mining and the total production has been large. In the thirteenth report of the State Mineralogist, pages 331–346, will be found much detail about the mining claims and operations in this region in 1896. See also Register of Mines and Minerals, San Diego County, 1902.

Earlier records are to be found in the twelfth report, pp. 237-243.

About 1896 or 1897 came into this region one S. W. Dorsey, who undertook to consolidate all local interests in one large corporation.

From this movement resulted successively the following companies: California Gold King Mining Company, organized about 1902, next the California King Gold Company, and finally, about 1906, the Picacho Basin Mining Company. In these companies were included about thirty claims of which sixteen were patented including the old Picacho group; Apache, Dulcinea, Eastern California, Golden Casket, Golden Rule, Extension, Mina Rica, Tierra Rica and Helen May. Also the White Gold Basin mines formerly of D. K. Allen, deceased, of Picacho. Albert Polhamus, Alcyon, Alfonso, Golden Crown, Golden Dream, Golden Hill, Golden Sunshine, Jita, Oriental, Ponce de Leon. Also the D. C. Jayne mines: Goshen, Mars, St. George and Venus. There were besides 6 mill sites.



Mill of the Picacho Gold Basin Mining Co. F.J.H.M. Photo.

The chief production of these consolidated properties was about 1904–06. In 1908 the 450-ton mill, which at first was on the river 5 miles from the mines, was moved to the latter. They closed down in September, 1910. The ore, which was of low grade, occurred in lenses in schist, dipping at an angle of 45°. The last shoot worked was 250 feet long and 160 feet wide. The managers were successively: J. Emerson Gee, of Los Angeles; R. K. Humphreys, Burdette Moody, of Pasadena, and E. W. Carson, of Los Angeles. The properties were sold under execution October, 1912, and are now held by the Ridgeway Estate through The Quaker City Bank of Philadelphia.

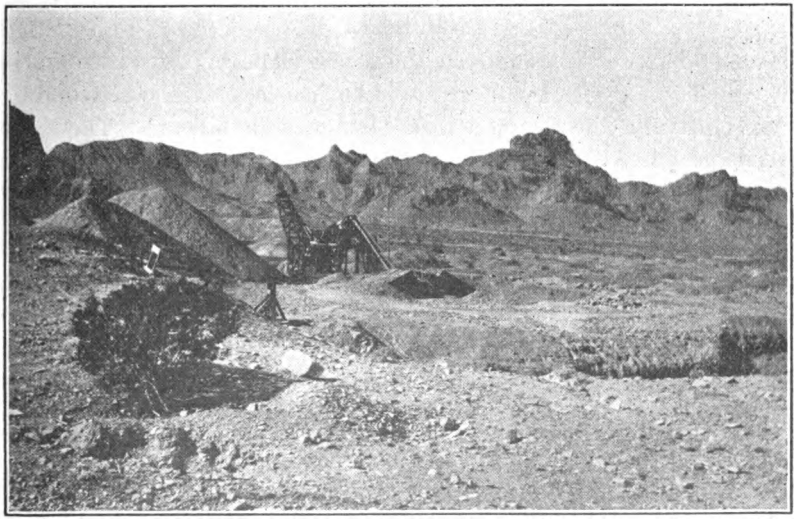
At present, owing to the general depression in the mining industry there is nothing being done in this district except development work on some placer claims.

Along the arroyo, between the Picacho mine and the village, is a

placer field on which several locations have been made. Wm. D. Sibley and T. A. Ashby have claims here and also Geo. Coryell, of Picacho.

Many of the old claims mentioned in the State Reports have been allowed to lapse and have been forgotten.

About seven miles by stage road in a direction N. 75° E. from Glamis are the old diggings of the Mesquite Placer, located in Sec. 21, T. 13 E., R. 19 E., at an elevation of 950 feet, the gravels lie along the washes of the present water courses, from the Chocolate Mountains, which drain into the bed of Dry Lake against the Sand Hills ten miles to the south. The placer gravels are in places fifteen feet deep but are not continuous and probably an average depth would not be over six feet. Water was packed from Glamis during the early work on the Bay Horse claim and the gravels panned and run through rockers. Some dry placering has also been done. Although the deposits are not continuous, but cut through by arroyos, they vary in width up to one half mile and extend for about two miles along the flank of the Chocolate Mountains. One of the principal owners is P. H. Ferguson, 4507½ Esmeralda street, Los Angeles, California.



Part of the Placer Field, Gold Basin. Picacho Peak in Background.
F.J.H.M. Photo.

Much gold is reported to have been taken from these workings in the early days and probably considerable areas remain which could be profitably worked with proper management.

In the same vicinity as the Mesquite Placer, the Erma Mining Company with twelve claims is doing assessment work on some quartz ledges in the schist. The gold occurs in pockets in the ledges which are seldom over three feet wide. These men are also doing some placer work.

No placering is reported to have been carried on in the region north of the Chocolate Mountains. Washes of considerable extent occur in that region and the possibilties look almost as favorable as they do to the south.

A few prospects of gold and copper-bearing ore are reported in Hodge's Mountains west of Rannels.

COPPER.

This material is shown by surface stains to be widely disseminated through a considerable area 3 miles southeast of Picacho village. Some drilling has been done here, without satisfactory results. At present Wm. D. Sibley and T. A. Ashby, of Picacho, hold a number of claims on this ground and are carrying on assessment work.

IRON.

A deposit of iron oxide, said to carry 50 to 60 per cent of metal, lies about 3 miles northeast of Mammoth Station at the foot of the Chocolate Mountains.

NICKEL.

This metal has been found on the south slope of Coyote Mountain by W. H. Trenchard, of San Diego, who has located a claim upon it. The ore is chiefly Garnierite, a nickel, magnesium silicate. The extent of the deposit has not been ascertained.

SILVER AND LEAD.

Silver occurs sparingly in connection with lead, 1 mile south of the Colorado River, 5 miles east of Picacho. This ore is lead carbonate and galena in small veins and pockets. Some of it has yielded up to 90 ounces of silver. Wm. Swain, of Picacho, holds some claims there. The principal one, called Mayflower, has a 90-foot shaft.

Located on the south side of a cove in the northern part of Barren Mountain is the old Paymaster silver mine. It would probably be located somewhere in the south half of Sec. 17, T. 11 S., R. 21 E., were the land subdivided. The claims were located about the year 1867 and worked for superficial chlorides. Supplies were brought in from San Francisco by boats which came up the Colorado River and landed near the mouth of Arroyo Seco to the northeast.

Water was pumped from the Colorado River by a plant located on Milpitas Wash near the mouth of Arroyo Seco.

At about the 400-foot level the rich ore had been worked out, and the silver values in the galena being low, the property was abandoned by the original owners. No work has been done since about 1880.

Late prospecting has shown that large bodies of galena, containing

low silver values remain. The ore body is about 42 feet wide at the bottom of the old workings. An assay of ore, taken from average samples across the ore body, is as follows:

Assay by the El Paso Smelting Company, of El Paso, Texas, for Mr. J. H. Lightfoot, of Blythe City.

Gold,	Trace.
Silver,	6.2 oz. per ton.
Lead,	73.3 per cent.
Copper,	.0
Insoluble,	7.2 per cent.
Iron,	.5 per cent.
Zinc,	0
Sulphur,	11.0 per cent.

The ore is said to lie along the contact of schist and granite and the ore body strikes about N. 45° E., and dips at an angle of about 75.° It is said that two 400-foot shafts were sunk at a distance of about 1,000 feet apart on the ore shoot, and 200 or 300 feet of stoping done in each shaft. In its days of production there was a stamp mill on the property, which was moved away. Three mining claims are at present held on this property by Robert de Luce, of Dome, Arizona, and William D. Hickey, of Neighbors, California. The claims are called El Tesoro, El Banquero, and Plata Real.

MARBLE.

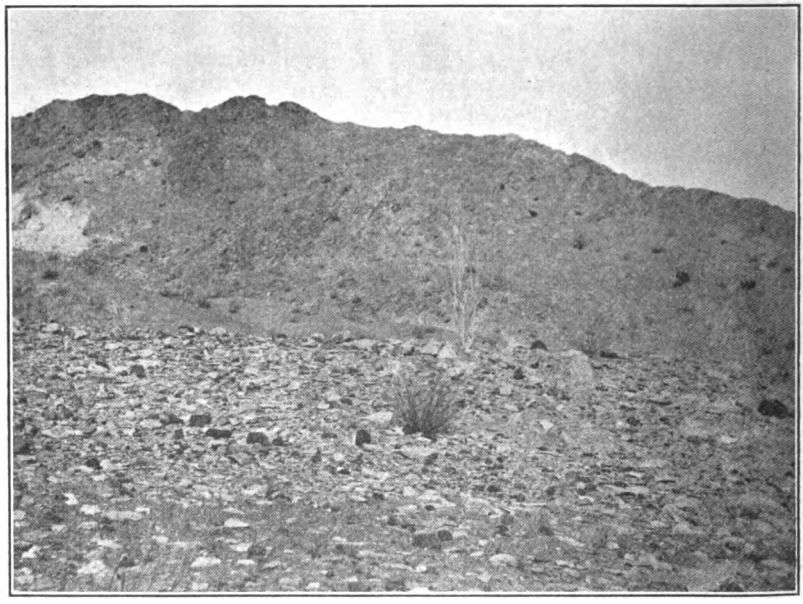
Bulletin 38, page 107.

The chief deposits of this material in Imperial County are in Coyote Mountain, T. 15 S., R. 10 E. This mountain is largely formed of crystalline limestone but not all of it is fit for marble. Here valuable deposits, within 6 miles of the San Diego and Arizona Railroad, now under construction, are owned and controlled by the Golden State Mining and Marble Company, 309 Watts Building, San Diego, C. A. Walker, president; H. H. Sparks, secretary.

This company owns fourteen deposits, each deposit being of different grade and color. Several have the grade and texture of famous imported marbles.

The Creole group consists of four claims of 20 acres each, covering an outcrop of marble about 4,500 feet long and averaging 600 feet wide. All of the development has been done on Creole claim No. 1. Here are three distinct strata of marble. The first is deep blue-black with a hardness of 3½, free from quartz, chert, or other impurity. It is of uniform color, free from holes or blemishes and is impervious to moisture so that it can not be stained even by red ink. The quarry will produce blocks of large size even at the surface. This is suitable for borders, exteriors and pillars and is probably well suited for monuments.

The second stratum on the Creole group is cream pink in color, with occasional blotches of red and black lines which, in the translucent marble, look like the so-called moss in an agate. This marble somewhat resembles the Italian Paonazza. It has a hardness of 3½, is exceedingly tough and free from impurities, takes a high polish and has the desirable quality of translucency when lights are placed behind a slab. This stone also resists stains of ink or oil.



Outcrops of Creole Marble, Coyote Mountain. F.J.H.M. Photo.

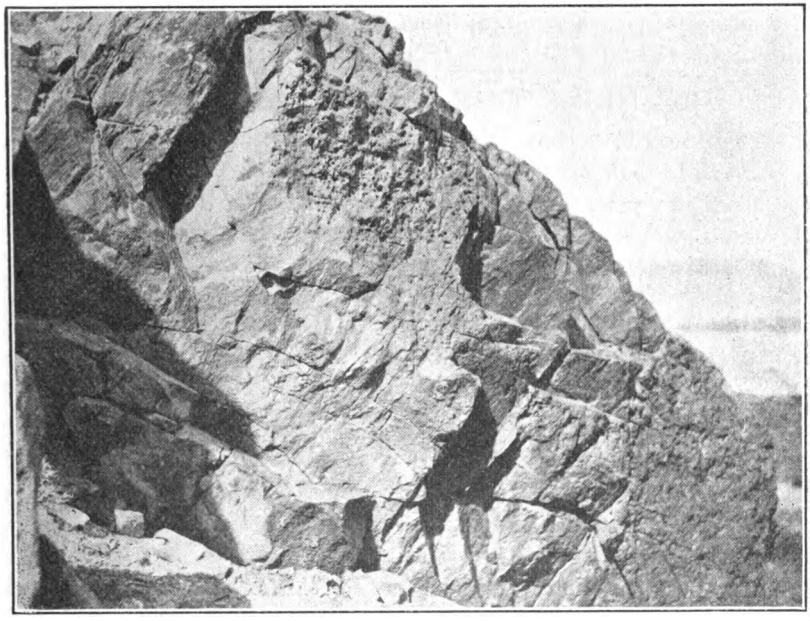
The third deposit of the Creole group is white with a bright green thread line. So far as known, this marble is in small blocks and suitable only for small borders or tiling.

About 2½ miles southerly from the above group is a deposit of marble varying in width from 30 to 400 feet and about 3,000 feet in length.

One end is mottled black and white marble, the color is distinctive. This deposit is solid at the surface. It takes a fine polish and does not show any strings or blemishes. It is suitable for corridors and for interior decoration.

About 600 feet on the other end of this deposit, the marble is very fine grained, and is highly colored in red, yellow, white, purple and blue. In one opening the stone is banded like agate in blue, red and yellow. This marble is over 3½ in hardness, grained like wood and takes a high polish, showing the colors of the African Numidian, as well as lighter and darker tints not seen in that stone.

Near the above deposit the company owns one claim, containing 20 acres of boulders, which appear to be concretions remaining from some overlying formation which has disappeared. The stone is not quite as hard as the ordinary marble, but takes a smooth, glossy finish and shows a great variety of color, including pink, cream, red, yellow, orange and



Creole Marble, Bored by Marine Mollusks. F.J.H.M. Photo.

purple, with dashes of green and slender black lines, brecciating the entire mass. This marble is of the Sienna type, but more beautiful and though it can not be obtained in large pieces, it can be used in tiling, soda fountains, knobs and handles for plumbing work, fancy articles and curios.

On the east end of the mountain and about one mile southeast of the above named quarries, this company owns a deposit of blue marble, closely resembling the Esperanza of Vermont. It is fine grained and hard, and is suitable for almost any work to which marble may be put, being especially adapted for monuments. Large blocks of uniform color are ready for shipment.

At the west end of the Coyote Mountain range is a deposit of marble, about one half of which is pure white and as translucent as opal. The other half is a peculiar marble, of lavender tint, without markings of any kind, and can be matched from any part of the quarry. Very little development work has been done here.

This company has erected buildings and ordered machinery for a plant at National City, on the line of the San Diego and Arizona Railroad for the exclusive cutting and finishing of this marble. One carload was shipped on the San Diego and Arizona Railroad last year via El Centro and Los Angeles, and 5 more carloads will be shipped during the coming year to the National City plant.

R. G. Fritz of San Diego also owns eight claims on marble in Coyote Mountain.

CRUSHED STONE, GRAVEL AND SAND.

These building materials are at present brought to the valley chiefly from Riverside County in the vicinity of Whitewater Pass. As the valley cities increase, their demand for such material will lead to the establishment of local plants, since there is an abundance of raw material on the margin of the valley.

LIME AND CEMENT.

On the south slope of the Coyote Mountain and at a point 3½ miles southwest of Coyote Wells are great deposits of limestone.

These deposits are from 3 to 5 miles distant from the survey of the San Diego and Arizona Railroad, and could be easily reached by spurs from that line. About a quarter of a mile from one of the largest deposits is a deposit of blue clay, averaging 70 feet in thickness and covering more than 300 acres of land.

The fact that this limestone carries little or no magnesia makes it ideal for cement manufacture as even a small content of magnesium is undesirable in high grade cement.

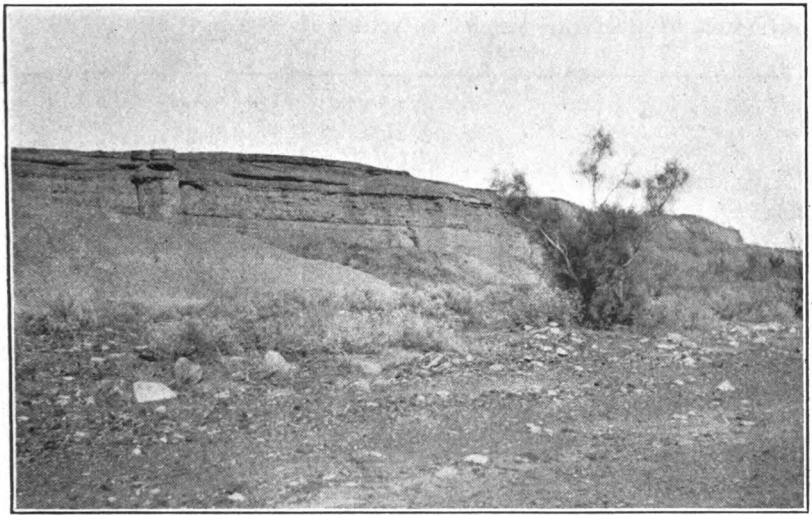
An analysis of a sample from Coyote Mountain by F. Salathé is here given:

Calcium carbonate	96.6
Magnesium carbonate	1.7
Silica	Trace
Alumina and iron sesquioxide	.9
Calcium sulphate	.5
Totals	99.7

The raw materials for Portland cement are very abundant on the west side of the Imperial Valley in great deposits of Tertiary clay and crystalline limestone, which are close together, and will soon be within reach of transportation. As the population of the valley increases, there will be a great demand for Portland cement for the lining of irrigation ditches and the local material will doubtless form the basis of a large manufacturing plant.

BRICK.

At various times and at various places in the Imperial Valley, local brickyards have been established and operated for a short time. These now have all been superseded by the Simons Brick Company, main office, 125 West Third street, Los Angeles. Joseph Simons is president and Walter R. Simons, secretary. This company operates at El Centro, about one mile south of the station, a plant for the manufacture of



Miocene Tertiary Clay. Near Coyote Mountain. F.J.H.M. Photo.

common brick and hollow tile, equipped with two stiff mud and brick machines. The clay used is the local silt of the valley, which is very fine and sticky, requiring much power to work it. This deposit continues unchanged to a depth of 1,500 feet, as shown by local borings, but varies slightly in texture and the proportion of sand present, the variations in composition occurring every 3 or 4 feet. This variation enables the brick maker to mingle layers of different qualities and form a brick mixture of suitable character.

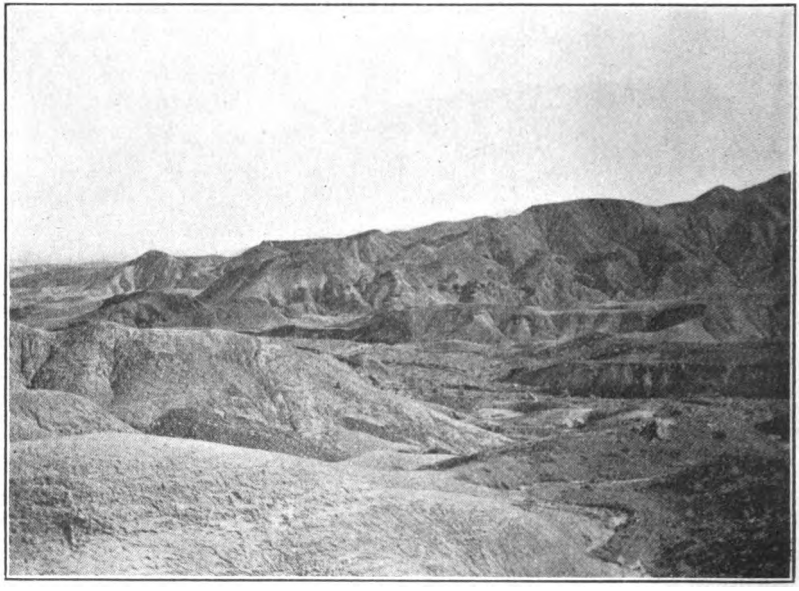
The plant is operated about 3 months in a year, and the production is about 4,000,000,000 brick and 200,000 hollow tile.

TERTIARY CLAYS.

Clays, many miles in extent and, perhaps, hundreds of feet in thickness, are found on the west margin of the valley toward Carrizo Creek. These clays have never been carefully sampled, but it seems reasonable to assume that, in them, strata will be found, suitable for various purposes.

GYPSUM.

This material, the hydrous calcium sulphate or sulphate of lime, is of much importance in construction as the calcined product, plaster of Paris, is the base of nearly all wall plasters for interior work. It also forms the base of the material known as staff which is so extensively used in the construction of temporary buildings for exposition purposes. Gypsum is also important as a fertilizer in supplying lime and in correcting alkaline soils. In small quantities, it is used in the manufacture of Portland cement to retard its setting.



Miocene Tertiary Clays. East Side of Coyote Mountain. F.J.H.M. Photo.

The gypsum of Imperial County occurs mainly in an immense deposit some three miles in length from southeast to northwest, with an area of some 800 acres, which occupies a valley, among crystalline rocks, in the northwestern edge of the Fish Creek Mountains. This spur from the crystalline ranges of San Diego County, as shown by the geologic map, lies chiefly in townships 13 and 14 south, ranges 9 and 10 east. The gypsum outcrops are in Sections 19, 20, 28 and 29, T. 13 S., R. 9 E. It has not been thoroughly explored by boring to determine its depth but, from the exposure in ravines, its average thickness is estimated at 100 feet. This is claimed by the owners to be the largest deposit of pure gypsum on the Pacific Slope.

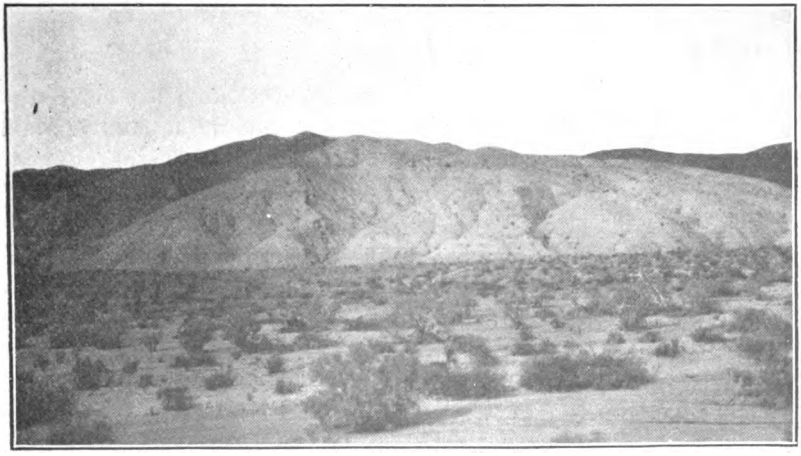
The following analysis made by J. O. Handy, of Pittsburg, Pa., is furnished by one of the owners:

Silica	.92
Alumina	.21
Iron protoxide	.14
Lime	32.75
Magnesia	.08
Sulphur trioxide	47.17
Water	18.73

The ownership of this deposit is distributed as follows:

Acres	Location	Owner
120	SE. ¼, SW. ¼; S. ½, SE. ¼; Sec. 19	Bert R. Chaplin, Suisun.
120	SE. ¼, NW. ¼; N. ½, SW. ¼; Sec. 20	S. L. Ward, San Diego.
160	SE. ¼, SW. ¼; SW. ¼, SE. ¼; Sec. 20	Walter O. Hamilton, El Centro.
	NE. ¼, NW. ¼; NW. ¼, NE. ¼; Sec. 29	L. E. Cooley, El Centro.
80	E. ½, NE. ¼; Sec. 29	W. H. Allen, San Diego.
40	NW. ¼, NW. ¼; Sec. 28	Sam C. Mack, Imperial.
40	SW. ¼, NW. ¼; Sec. 28	Ed H. Houck, Imperial.
80	NE. ¼, NW. ¼; NW. ¼, NE. ¼; Sec. 33	David Chaplin, Suisun. W. L. Gillette, Holtville.
	The above are all patented under the timber and stone act.	
160	NE. ¼, SW. ¼; NW. ¼; SE. ¼; Sec. 28 S. ½, SE. ¼	C. H. Swallow, San Diego.

None of these are patented.



Gypsum Outcrop. Fishcreek Mountain.

This deposit must necessarily become of great importance as soon as it is accessible to transportation. The new line of the San Diego and Arizona Railroad will pass within about 25 miles, and this will be rather too great a distance to haul a product of moderate value. Should the Atchison, Topeka and Santa Fe Railway build its contemplated line near the old highway from San Felipe through Carrizo Creek, the problem will be in a large measure solved.

Situated on the south slope of the Coyote Mountain range is another deposit of gypsum covering the better part of 10 acres. It is exposed over most of this area, has an average depth of 8 feet, and is said to show by measurements about 84,000 tons in sight, with a continuation under the overcap that can not be determined. The quality is said to be the same as that of the larger deposit to the north. This deposit lies about 3 miles northwest of Coyote wells and could be easily worked.

Gypsum Outcrop. Fishcreek Mountain.

GEMS.

The gem deposits so abundant in San Diego County are not found in Imperial County. Although pegmatite dikes occur at many points in the metamorphic rocks they do not contain the gem bearing veins. Further, the garnetiferous limestones of the Jacumba region do not extend east of the San Diego border.

A few peridots of good quality have been reported from the gravels of the Picacho region. On the slopes of Signal Mountain just across the Mexican boundary a few small turquoise have been found. From the region along the San Diego border some small diamonds are reported but this has not been confirmed.

PETROLEUM.

This important fuel has been sought by boring on the west side of Imperial Valley, but without result.

While Miocene beds are present in this valley it would appear that the conditions under which they were deposited were not specially favorable to oil formation.

The principal well was the Yuha, Sec. 32, T. 16 S., R. 11 E., drilled by the Yuha Oil Company, Chas. Swallow, of San Diego, secretary-treasurer. It reached a depth of 1,363 feet, but without result. An-

other well was the Mesquite, about 850 feet deep, in Sec. 27, T. 12 S., R. 10 E. This brought a supply of flowing water.

The Barrett well drilled near Carrizo Creek, to a depth of 1,100 feet, was also unsuccessful.

SALT.

Bull. 24.

An extensive deposit of salt was formerly worked near Salton, Riverside County, and if the Salton Sea should again become dry, salt may be found in this basin, within Imperial County.

NITRE.

Bull. 24.

Some years ago some claims were located near Volcano Station on deposits supposed to contain Nitre, but it does not appear that anything more important than traces of this material were discovered.

SULPHUR.

There is a small exposure of this mineral on the east slope of Coyote Mountain. A claim has been located by Chas. Swallow of San Diego.

Desert Springs and Wells.

The following list is taken from U. S. G. S. Water Supply Paper No. 224 by W. C. Mendenhall from data of G. E. Bailey.

"*Soda Springs.*—These are about 15 miles southeast of Fish Springs, on the road from Mecca down the west side of the Colorado Desert. The water is so salt as to be scarcely potable and near by are other springs whose water is entirely undrinkable. Soda Springs are at the base of a low barren knoll, one-half to three-quarters of a mile south of Clay Point, marked by a government bench mark, around which the road turns west on the way from Mecca to Seventeen Palms Springs. The road from Clay Point south toward Harper Well is very little traveled and is difficult to find.

"*Fish Springs.*—Fish Springs (230 feet below sea level), in 1908 submerged to a depth of about 25 feet beneath Salton sea, are a group of strong natural springs whose aggregate yield is several miner's inches. The waters are tepid and slightly saline, but of sufficiently good quality to be used by men or animals without injurious effects. Before their submergence, these springs were especially important to travelers because they were at the southernmost point at which water of fair quality can be procured in abundance along the west side of the desert until Harper (Mesquite) Well is reached. They will emerge again as the lake shrinks by evaporation, and when the lake water has become too saline for use they will again become important. Their position is indicated by a prominent rocky point which stands out in a desert about a mile east of the Santa Rosa Mountains, and which is conspicuous not only because of its position but because of the

distinct water line that encircles it 10 to 15 feet below its summit. This point is about 2 miles northeast of the springs.

"*Frinks Springs.*—These are about 6 miles northwest of Frinks Station, on the Southern Pacific Railroad. They are on one of the old wagon roads from San Bernardino to Yuma, near the old beach line that stands about 40 feet above sea level in the Colorado Desert. The water is of good quality and in fair quantity.

"*McCain Springs.*—These springs are about 5 miles somewhat east of south of Clay Point, mentioned in the description of Soda Springs. They are in the center of a broad wash, locally called Arroyo Grande, and are marked by three large sand dunes from a quarter of a mile southwest. The surrounding country is traversed by numerous gulches from 6 to 20 feet in depth and often difficult to cross. The springs, which are well below sea level, have built up a small mound in the bed of the wash. The water appears to be charged with carbon-dioxide gas and is fairly palatable.

"*Harper* (or Mesquite) *Well.*—Near the junction of Carrizo and San Felipe creeks an attempt was made some years ago to develop oil. No oil was found, but at a depth of about 300 feet a flow of good water was obtained. The site of the well is plainly marked by the derrick, which can be seen for a long distance across the plain. There is an abundance of mesquite timber in the vicinity.

"*Kane Spring.*—This is 6 miles east of Harper Well, on top of a low knoll. It is surrounded by cane, salt grass, and arrow weed. The water is full of soda and is very poor, being hardly fit for use.

"*Coyote Well.*—This well is about 375 feet above sea level, on the main stage road from Mountain Springs to Dixieland. The old Coyote well was a mere pit curbed up with planks. A new well, standing about 100 feet from the old one, was fitted up with a pump. The water is rather alkaline, but improves after the well has been used for some time.

"*Yuha Springs.*—These springs are located in a wash near the corner of sections 5, 6, 7, and 8, about 5 miles southeast of Coyote well and a mile southwest of the derrick at the Yuha oil well. The stage road from San Diego to El Centro passes about 2 miles north of the springs. The water is impregnated with alkaline matter, but when used continuously is not unpleasant or harmful. In 1905 there was a trough and pump at the springs.

"*Sunset Springs.*—These springs, which have long been known, are about 13 miles south of east from Brawley, below the old beach which is so prominent a feature about the borders of the Colorado Desert. They are of less importance now than before the reclamation of so large a part of the Imperial Valley by irrigation with Colorado River waters."

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*1906	Various	Structural and Industrial Materials	Bulletin No. 38.	
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*Now on sale.
N. B.—All of the above publications contain references to Imperial County, as they were issued before it was separated from San Diego.