

SAN BERNARDINO COUNTY.

By W. H. STORMS, Assistant in the Field.

No portion of California has more diversified mineral wealth than the county of San Bernardino. Although its area is comprised largely of rugged mountains and desert waste, yet this county is a producer of gold, silver, copper, lead, and tin, and contains mines of zinc, iron, and manganese, besides deposits of borax, salt, soda, baryta, gypsum, sulphur, onyx, marble, asbestos, and structural material, granite, and sandstone of great beauty and value. Within its borders are found a wide range of geological formations from Paleozoic (if not Archæan) to Tertiary, and a great variety of rocks of igneous origin.

The mines are scattered all over its thousands of square miles of territory, and have already added millions of dollars to the wealth of the State and the world. Many of its mines are of phenomenal richness, and were it not for the expense and extreme difficulty attending transportation in the desert, San Bernardino County would undoubtedly take first place in adding to the mineral wealth of California. The largest and most productive section in the county at present is

THE CALICO MINING DISTRICT.

No region affords better opportunities for the study of a certain class of ore deposits occurring in eruptive and fragmental rocks than may be found in the Calico District. The mines, condemned at first, came quickly to the front nevertheless, and have for the past twelve years been steady producers of silver bullion. The district is situated 6 miles north of the Atlantic and Pacific Railroad, the nearest station being Daggett.

GENERAL GEOLOGY OF THE REGION.

The geology of the Calico Mountains at first sight looks simple enough, but a more thorough investigation quickly convinced me that there were structural problems to be studied of more than passing importance, as they seemed to have a bearing upon the extent of the ore deposits. The most complex region is that immediately about the town of Calico, in the vicinity of the mines. The balance of the mountain area is more simple.

In a general way the Calico uplift consists of a core of massive rhyolite, overlying which are heavy deposits of light-colored breccia and tufa. Along the flanks of the range, and in some places extending well up into the mountains, are accumulations of undoubted sedimentary origin, sandstone, sandy shales, and argillaceous rocks, which, with some local exceptions, dip away from the central mass on all sides toward the desert plain. While in the district I made some notes on the general geological features, but not having sufficient time at my

disposal to complete these investigations, I have determined not to present my views until I have had an opportunity to investigate the region more carefully.

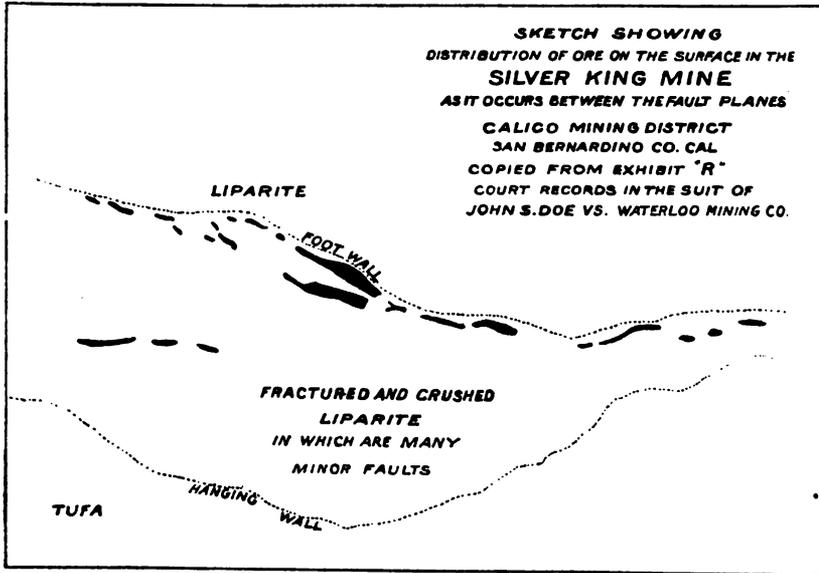
Subsequent to the uplift of these mountains, erosion has carved deep cañons and removed great mountain masses. The central area is now entirely denuded, whereas it was at one time covered with from 100 to 200 feet of tufa and upward of 1,000 feet of sedimentary strata. Not only have these more recent accumulations been removed, but a large amount of the hard, dense liparite has also been disintegrated and carried away by the violent storms which are characteristic of the desert. Faults are very numerous throughout that portion of the mountains lying along the south side of the range. They extend for at least 10 miles in an easterly and westerly direction. The mines occur along this faulted zone.

The rocks of the region are a violet to brown rhyolite, often porphyritic; green, yellow, and white tufa; yellowish and greenish breccia; a greenish gray, fine-grained rock, which has been called hornblende andesite by Mr. Lindgren, and a yellowish or buff to light gray felsitic rock, which may be either rhyolite or an older felsite. It is extremely difficult to distinguish between these rocks, even with the aid of thin sections under the microscope. I think, however, upon structural grounds, that I may call the rock felsite. As this is one of the important questions upon which I have not thoroughly satisfied myself, it will be left until such time as I have opportunity to make the necessary investigation.

THE ORE DEPOSITS.

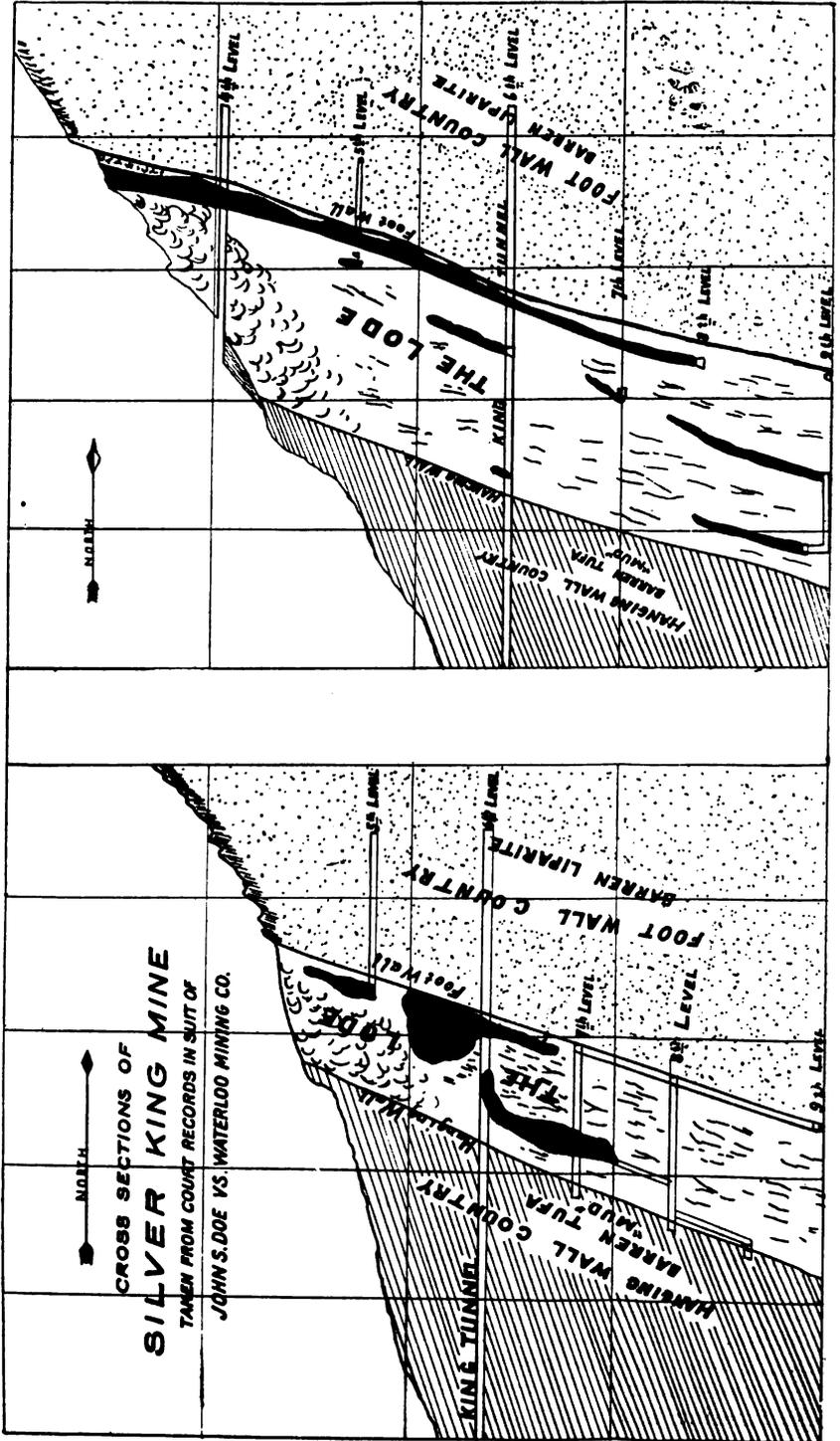
The formation of the ore deposits in the Calico District has been a subject of much discussion, and the question has received the closest study and thorough investigation. In my opinion, the ore deposits were formed through the agency of percolating waters carrying mineral solutions, which deposited their contents along fault planes and in certain zones of the country rock, where its brecciated and crushed state offered superior conditions for the deposit of the silver ores and the accompanying baryta. That all of these ore deposits have a common genesis I do not doubt, whether they occur in the liparite, in the tufa, or in the "mud" overhanging country rock, as is the case at the Bismarck, Humbug, Waterloo, and some other mines. The form of the deposits differ somewhat, it is true, for we find the reticulated veins in the King Mine; the segregated deposits in the Odessa and Waterloo; the fissures in the Langtry, in West Calico, and the impregnated deposit in the Humbug. However, all the deposits of the district, of whatever form, I believe are due to a common cause, having been deposited in their various forms from mineral-bearing solutions which derived their contents from the neighboring eruptive rocks (the liparites and tufas), part of the material doubtless arising from great depth, and a portion coming from the adjacent inclosing rocks by what is known as lateral secretion. It is almost an impossibility to find in the Calico region a piece of rock that does not contain more or less silver, from a fraction of an ounce per ton upward.

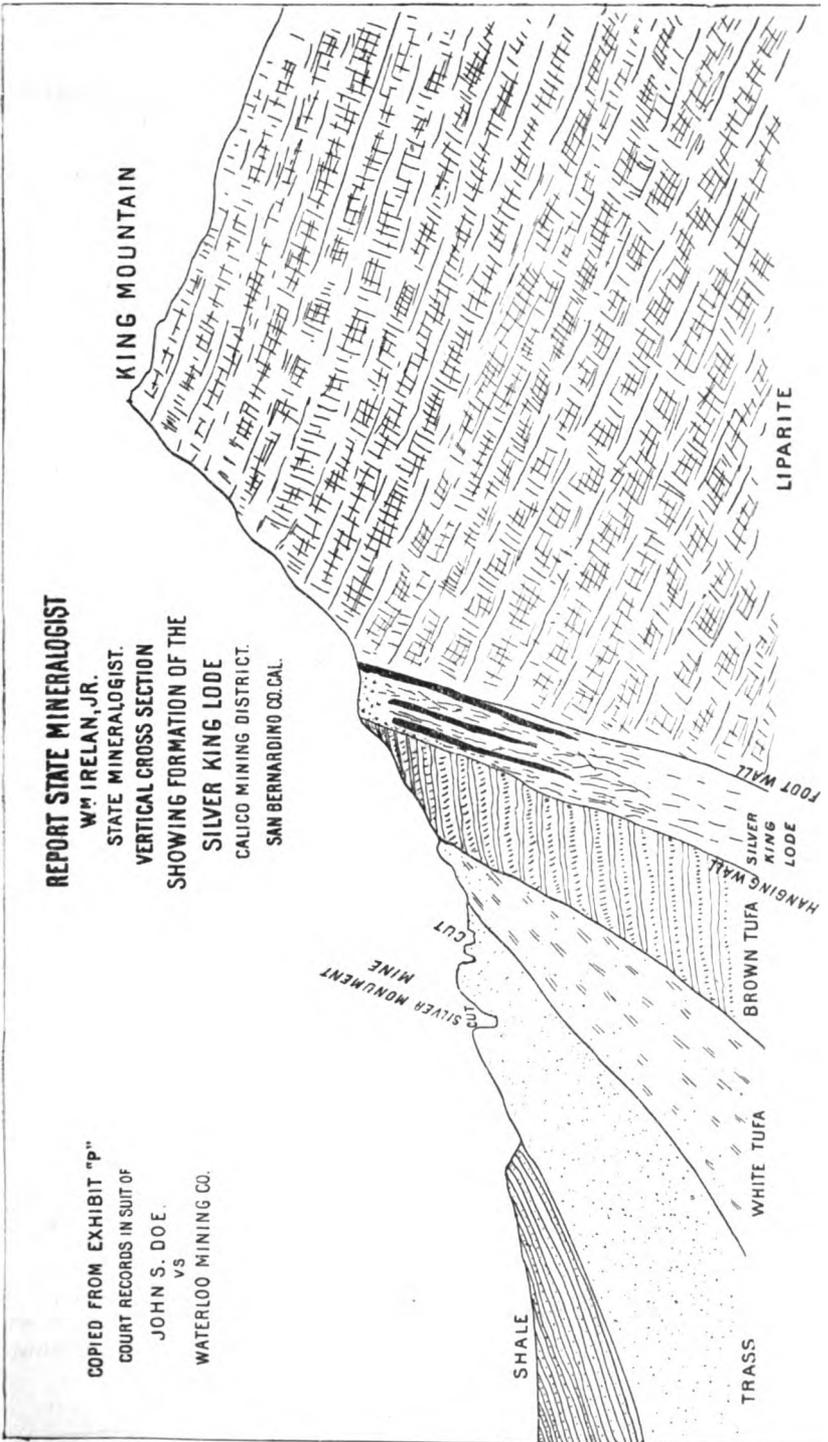
The phenomena of ore deposition was very thoroughly investigated by Messrs. Louis Janin, E.M., John Hays Hammond, E.M., Ross E. Browne, E.M., and Wm. Ireland, Jr., State Mineralogist, at the time of



the lawsuit of John S. Doe vs. Waterloo Mining Company. These gentlemen all agreed upon the origin of the ore deposits, and their opinions coincide with my own and are in accordance with the ideas expressed above. The wide difference in the size and form of the many ore bodies does not in any manner conflict with the theory that in each instance the primary cause of the deposit was a fracturing and crushing of the rock masses and the subsequent infiltration of mineral solutions, which precipitated their contents in the zones and crevices thus prepared for their reception.

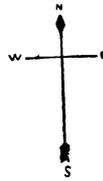
In the Silver King Mine occurs a perfect network of veins, concerning which Mr. Hammond testified: "At the time of the uplifting of the liparite, or at some subsequent time, a fault occurred, which separated a wedge-like mass of liparite from the main mountain mass, and this fault plane was generally conceded to be what might be termed the foot wall of the mineral belt, or zone, or lode. Contemporaneously with this faulting a second fault occurred, which separated the overlying brown tufa from the liparite, which fissure forms the overhanging wall of the mineral deposits of the Silver King Mine. At the same time cross fissures were formed in the liparite mass between the two main fissures. Thus there was a main fissure or plane of contact between the brown tufa and the liparite, and a similar fault plane between the segment of liparite broken off and the main mass of the mountain. Between these two main fissures, and throughout the whole mass of this segment of liparite were innumerable fissures, some similar and equal in size to the main fissures, and others forming a finer system of fissures and cracks, extending through the rocks in all directions, leaving it in a broken and disintegrated, and in many places an almost pulverized condition. Although these finer fissures generally had a parallelism with the two main fissures bounding this segment of rock, yet, in many places, these finer seams or fissures run in every direction through the rock, forming a network, or reticulated mass. The mineral-bearing



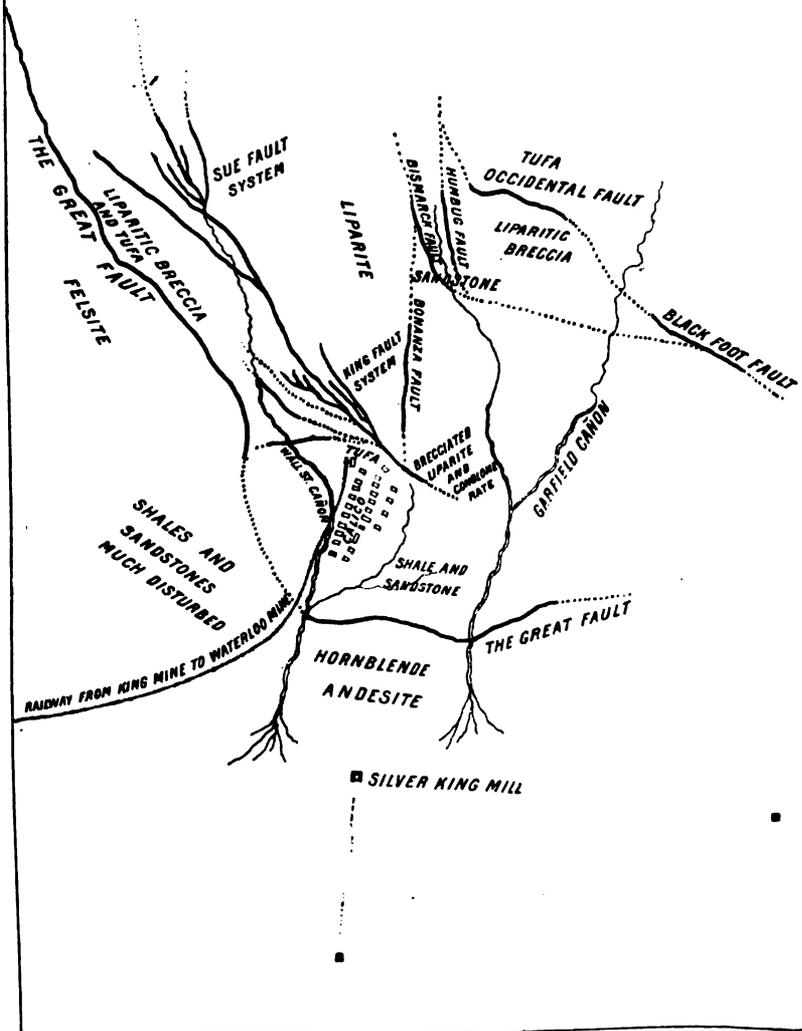


REPORT STATE MINERALOGIST
 W.M. IRELAN, JR.
 STATE MINERALOGIST.
 VERTICAL CROSS SECTION
 SHOWING FORMATION OF THE
 SILVER KING LODGE
 CALICO MINING DISTRICT.
 SAN BERNARDINO CO. CAL.

COPIED FROM EXHIBIT "P"
 COURT RECORDS IN SUIT OF
 JOHN S. DOE.
 VS
 WATERLOO MINING CO.



STATE MINERALOGIST'S REPORT
W^m IRELAN, JR.
STATE MINERALOGIST.
*SKETCH MAP SHOWING THE FAULT SYSTEM
OF THE CALICO MINING DISTRICT*
PARTLY TAKEN FROM A MAP
BY
W. LINDGREN, E.M.
BY
W. H. STORMS, E.M.
ASSISTANT IN THE FIELD.



waters have deposited throughout this mass, from wall to wall, the minerals now found within this zone in the form of baryta, carrying silver. The finding of baryta in the shattered planes of the liparite, which is entirely foreign to the rock itself, is sufficient evidence that a crack or space must have existed prior to its deposition, from the solutions which penetrated this broken zone of a once massive rock formation."

The Odessa Mine offers good illustrations of impregnated masses, as does also the Waterloo. In each of these mines, as in many others, the ore bodies are found in bunches or pockets, varying from little deposits of nominal value to great ore chambers containing thousands of tons of pay rock. In these cases, as at the King Mine, a system of faulting planes marks the general strike of a mineral-bearing zone or lode, but the great rock masses of tufa, in which these ore bodies occur (and also of sandstone in the Waterloo), are quite loose and porous in texture, and undoubtedly the ore bodies in these mines resulted partially, at least, from the impregnation of the rock with the mineral solutions which found an easy passage along the fault planes that had cut the rocks in every direction.

In the Waterloo Mine one of the fault planes exhibited a regularity seldom seen in any mine. It coursed through the light-colored, soft tufa in an easterly and westerly direction, was perfectly true, and as smooth as any hard-finished wall could be made by the most skillful artisan. The fracture was of knife-blade thinness, and its sides were coated with dark red iron oxide. It dipped to the southward at an angle of about 40° . At one time it was considered to be the hanging wall of the lode, but a miner broke through the wall to cut a hitch for a timber and it was found that the overlying rock beyond the slip was ore-bearing also. Stopes in this mine were frequently over ten sets in width, or over 60 feet. At the eastern end of the claim some extremely rich ore was mined from a belt of jasper, a metamorphosed clay shale, which by heat and pressure had become an intensely hard, fine-grained, flinty rock, yet some of this jasper contained over 1,000 ounces of silver per ton.

In West Calico, 2 miles west of the Waterloo, is the Langtry group of claims. The principal development is on the west end of the Langtry Mine. The Langtry may be called the anomaly of the camp, as it is a fissure vein pure and simple, or, more strictly speaking, two fissures.

The strike of these two fissures, which are 60 feet apart, is nearly parallel, but they will undoubtedly meet in depth. That on the south side dips northerly, while the other pitches toward the south slightly. Both stand at a high angle, and it is doubtful if they will converge inside of 250 feet from the surface. The veins are composed principally of a coarsely crystallized baryta with quartz, containing brown iron oxides, lead carbonate, ochre, manganese oxide, and chloride of silver. The average value of the ore was about 22 ounces per ton. The veins vary from a thin seam to over 10 feet in width on the north vein, having an average width of 3 or 4 feet. These veins occur in the "outside" or "mud" country, which lies along the flank of the southern slope of the Calico Mountains. The mud shales and argillaceous sandstones here lie nearly horizontal, the veins cutting them at an angle closely approximating 90° .

SUSPENDED MINING OPERATIONS.

The low price of silver during the past two years has resulted disastrously to the mining industry in Calico District. The great Waterloo, for many years the largest producer, and employing not less than 150 men in mines and mills, was closed down, as it seemed foolhardy to exhaust the great ore bodies when the profit derived from the extraction and milling of the ores was merely nominal. For years these mines had kept the sixty-stamp Boss process mill and the fifteen-stamp pan mill at Daggett busy night and day, but in the spring of 1892 the stamps were hung up and the mines closed, awaiting better prices for silver.

The Silver King Mining Company (limited), of London, has continued to operate, dropping twenty to thirty stamps night and day, under the superintendency of William S. Edwards. The King Company owns or controls three important groups of mines in this district, viz.: the Odessa, the Oriental, and the Occidental. The Odessa made a record during the early history of the camp by the production of ores of high grade. The policy which was pursued in those "palmy days"—to gouge out the rich ore whenever it could be found, without regard to future condition of the mine—left most of the mines in very bad shape. The Odessa is now recovering under the new management, and the property is being systematically opened, and it is thought all the ore can be extracted. In this mine are stopes from which thousands of tons of ore have been mined, and there is not a stick of timber of any kind in them.

These old stopes are being cleaned out, new levels opened, and good results are expected in the future. What applies to the Odessa in this respect is true to a great extent of every other large mine in Calico. They were all worked in a hand-to-mouth sort of fashion, and although many of these mines paid handsome dividends, little of the money was ever put back in anything like permanent improvement. All seemed to share a common opinion—that the deposits were superficial, and would not go down, and as a result no one felt like laying out money in an extravagant and unwarranted manner. But the mines have gone down, and the men in charge of the mines to-day can see the result of the mistaken economy of the early operators, and see in Calico an era of recovery of low-grade ore bodies and development work which is calculated to give the mines greater apparent permanency than ever heretofore. December 1, 1891, the King mill was enlarged by the addition of ten stamps, making thirty in all. The Boss process of continuous amalgamation was also adopted.

CHLORIDING THE MINES.

A system of leasing portions of mining claims, called "chloriding" in Calico, was introduced in the early days, and is still in vogue. Many poor men have made moderate fortunes in the district, and in days gone by all did well. The mines are leased on a royalty of one fourth to one sixth of the ore to the claim owner, according to its value, the owner receiving more as the grade is higher. Chloriders were at work on the Loo, Little Waterman, Humbug, Bismarck, Blackfoot, and other mines, during the past year. The ore obtained in this manner is usually sacked and shipped to a custom mill, where it is crushed, the charges ranging from

\$9 to \$12, according to the character of the ore, some (the more brittle) milling much faster than others.

THE WATERLOO MINE.

The Waterloo property consists of four claims. The principal workings are in the Waterloo Mine, where large stopes have been extracted, though considerable amounts of ore still remain in sight. An idea of the extent of some of these Calico mines may be gained from the fact that the great ore body of the Waterloo is 1,100 feet in length, and is known to extend from the surface down to the 525-foot level. At the east end the ore-bearing zone is from 4 to 7 feet in width, widening downward. Going westward it increases in width until it is 60 to 70 feet wide. This mine, like those immediately about Calico, was worked for rich pockets, and, as a natural consequence, the mine was left in bad condition. Jos. D. Kerbaugh, the last Superintendent of the mine, had inaugurated a systematic method of extracting ore and recovered much lost ground. The ore is usually low grade, and this, in connection with the low price of silver, has resulted in the closing up of the mines. A narrow gauge railroad has been in use for several years to transport the ore from the Waterloo group and the King and Red Jacket Mines, owned by the same company, to their mills at Daggett, timber and supplies being brought to the mines on the return trips. The transportation of ore, I was informed, cost 12 cents per ton. The railroad is about 7 miles in length, and runs on a pretty steep grade.

THE BORAX MINE.

In the upturned sedimentary beds which flank the Calico Hills, dipping outward toward the desert plain on all sides of the uplift, except where purely local disturbances have caused a reverse condition, are bedded deposits of calcium borate and gypsum (calcium sulphate). Five miles east of the town of Calico is the largest known deposit of calcium borate in the district. The bed, or vein, as it is called, was discovered some years since, and finally passed into the hands of the present owners, the Pacific Coast Borax Company, whose extensive works are located at Alameda, near San Francisco.

GEOLOGY OF THE BORAX DISTRICT.

The borax mine occurs as a bedded vein in the sedimentary strata, which in Tertiary times were uplifted in the Calico range. The sediments are composed of sandstones, sandy clays, and clayey sands, comprising a succession of heavy-bedded, deep-water deposits, and shallow-water, thin-bedded shales and sands. These variations in the character of the strata are numerous, and mark the many oscillations of the region, whose rising or sinking either submerged the strata beneath the waters of a deep lake, or lifted them until the water flowed over the mud flats only in thin sheets, which, exposed to the rays of the sun, sometimes evaporated entirely. Climatic conditions doubtless also were an important factor in the history of these strata, which are upwards of 1,000 feet in thickness.

Underlying the sediments are the tufas of the Calico region, and

beneath them is found the mass of liparite which underlies this entire region. The sediments are not materially different from those in the immediate vicinity of Calico. The rocks have not suffered in the region about the borax deposit the slightest metamorphism.

The borax vein is traceable for several thousand feet, striking along the western and northern side of the largest sedimentary hill in the range, and finally passing down a cañon to the eastward, where it becomes a well-defined vein. Toward the western end the borate of lime appears to be much mixed with the sandy sediments, gypsum, and clays, giving the appearance of having been formed near the shore line of the basin in which this great mass of material has been left as a residuary deposit, due to the evaporation of the water containing the calcium borate.

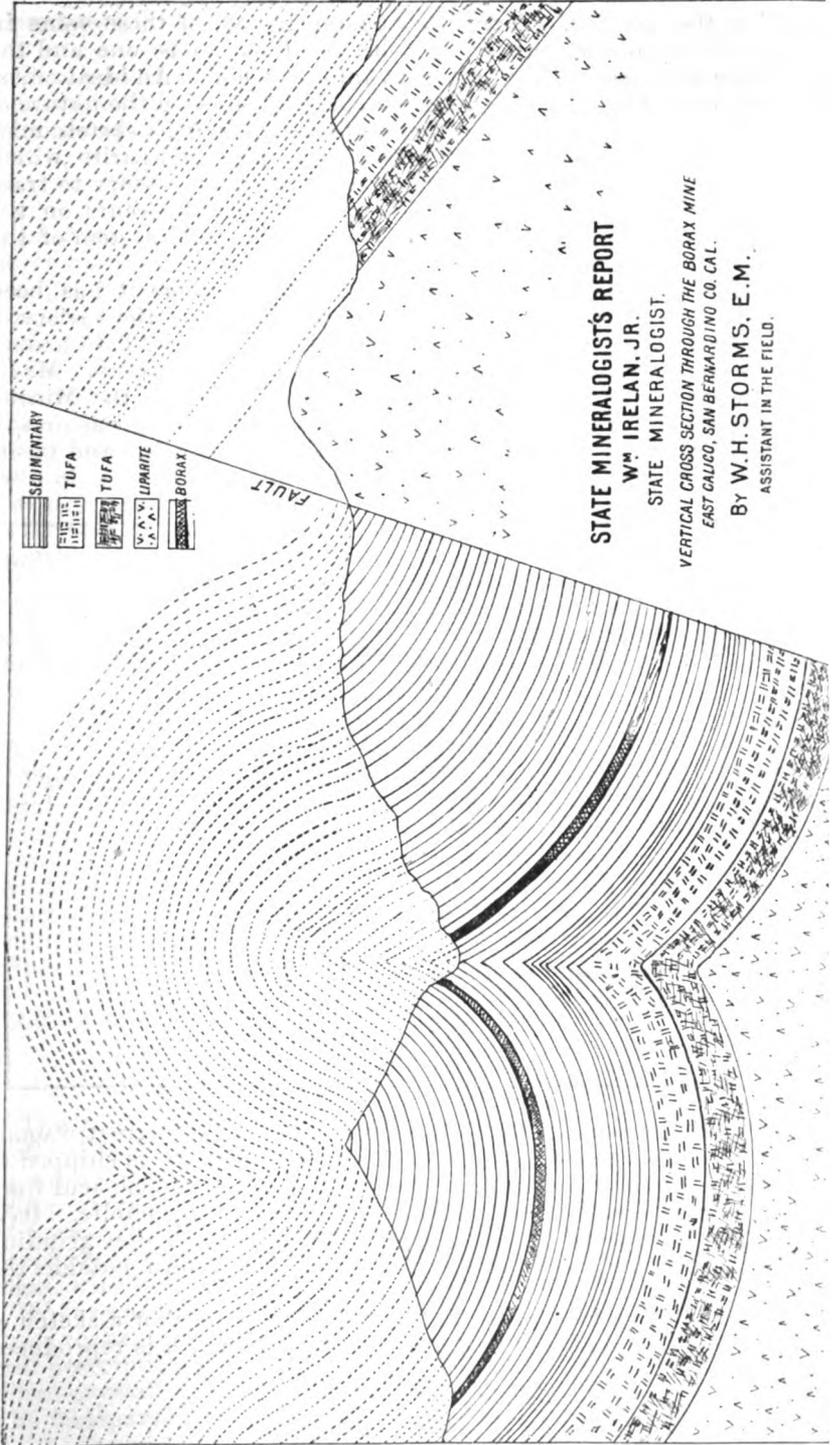
To me it seems that what is now one of the most valuable deposits of mineral in the State was at one time the site of a Tertiary lake of considerable but as yet undetermined size. That although subjected to the same oscillations as the remainder of the region a basin formed, in which the waters collected, carrying with them the mineral salts derived from the rocks of the neighboring country. That finally the climatic conditions became such that the supply of water was less than the loss by absorption and evaporation, and the waters of the lake slowly diminished, it finally disappearing entirely, leaving on the floor of the lake a thick deposit of calcium borate of snowy whiteness.

After the deposition of the borax bed a general subsidence of the region occurred, the waters of the great Tertiary lake once more covering the whole country. Again the sands and finer sedimentary material—the erosion of the mountains—were carried down and found a resting place on the floor of the lake, the borax bed being finally covered with several hundred feet of this detritus. Now, as the same formation in which the borax mine is found, and even the lower members of the rocks of that age, are seen resting upon the high ridges and on some of the peaks of the Calico hills, it would seem highly improbable, to say the least, that these sediments were built up from the ruins of the Calico Mountains themselves, but their source was in more distant ranges.

Besides the regular vein-like deposit of calcium borate found at the borax mine, there are numerous small veinlets in other parts of the district in which calcium borate and gypsum are found filling cracks and cavities, probably as the result of infiltration. So common are these small fissures and beds of borax and gypsum that that portion of the sedimentary strata lying east of the town of Calico is usually spoken of as the borax formation by the miners of the district. To thoroughly investigate all the phenomena connected with these wonderful deposits and their mode of formation would require more time than was at my disposal.

As has been previously stated, remnants of the sediments are still found lying high up on the flanks of the mountains, and even far into the interior of the hills, and there is every probability that the entire region included in the Calico District, as well as the country for many miles around, was at one time buried a thousand feet beneath these stratified rocks.

With the uplift, the strata inclosing the borax mine were tilted and folded, and now the sheet of white calcium borate which once lay glistening in the sun on the bed of a desert dry lake stands like a great vein



STATE MINERALOGIST'S REPORT

W^m IRELAN, JR.

STATE MINERALOGIST.

VERTICAL CROSS SECTION THROUGH THE BORAX MINE
EAST CALICO, SAN BERNARDINO CO. CAL.

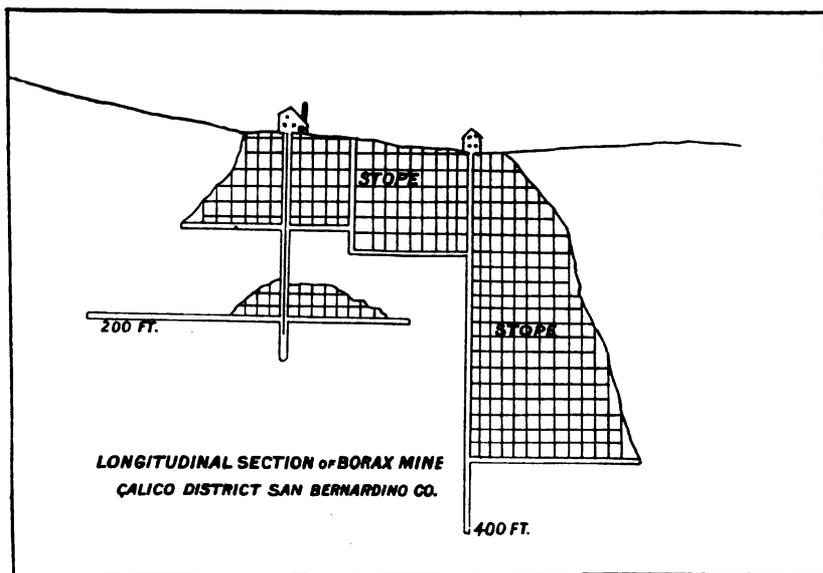
By W. H. STORMS, E. M.

ASSISTANT IN THE FIELD.

traversing the country. There are apparently two of these veins in close proximity to each other, but I believe them to be one and the same, being repeated as the result of an anticlinal fold. An ideal cross-section of the borax mine is here given (p. 347), showing the nature of the folding at that point; it is not drawn to a scale, being a sketch only.

To the southward of the mine is seen a large mass of liparite, which has been pushed up from below. I had not the time necessary to trace out the line of fracture, but I am of the opinion that it occurs on the line of the great fault shown on the map of the fault system of the region.

The borax vein is from 7 to 10 feet in thickness where it has been exposed in the underground workings. The mineral is the variety of calcium borate called colemanite, named in honor of Wm. T. Coleman. It occurs in glassy crystals, some of them having large faces. Many handsome specimens of this mineral are on exhibition in the Mining Bureau museum. The mineral is mined in the same manner as ores of gold or silver. Inclined shafts are sunk on the vein, drifts and levels run, and the stopes carried up as in any other mine.



The material, when hoisted to the surface, is loaded in great wagons hauled by twenty animals and taken to Daggett, where it is shipped to the works in Alameda. The process of extracting the boracic acid from the rock as practiced in these works is not given to the public. It is known that the mineral is crushed and bolted like flour, after grinding with burrs, but the subsequent treatment is not known outside the works.

To the Superintendent, J. W. S. Perry, I am indebted for a sketch of the underground working of this remarkable mine, which is reproduced above.

AGE OF THE UPLIFT.

The geological age of the Calico uplift has not been accurately determined, though there is little doubt that it occurred during the Tertiary age, probably the Oligocene.

THE IRON MINES.

In this county, about 16 miles in a southeasterly direction from Newberry Station, on the A. & P. R. R., and 28 miles easterly from Daggett, are the greatest deposits of iron ore on this coast. They consist of immense beds or masses of hematite and magnetite ore, containing a high percentage of iron, with traces only of sulphur and phosphorus. These mines have been known for many years, and they have had numerous owners by relocation and purchase, but nothing has yet been done with them. Iron men from Pittsburg and Cleveland and elsewhere have visited these mines and secured samples, and all reported favorably on the excellent quality of the ores, but there the matter was dropped.

Located 16 miles from the railroad, and probably 20 miles by any possible line of railway survey, as the grades are heavy, with neither fuel nor water, the problem of their reduction was so formidable that none dared face it, and for years this magnificent property has been waiting for some one with capital and a "process" to come and make the vast wealth available.

THE LAVA BEDS DISTRICT.

This interesting region has come quite prominently into public notice within the past two years. The district is located in a small range of mountains about 35 miles east of the Calico range. The nearest station to the mines is Lavie, on the line of the A. & P. R. R., from which point the mines are 9 miles distant by a good wagon road. Like most other desert mining regions it is destitute of timber, and water is not abundant, though obtainable in the dry lake basin $3\frac{1}{2}$ miles from the mines. The district was discovered about nine years since, and numerous claims have been located. The work of development has been confined to a few of the most promising claims.

GENERAL GEOLOGY.

The mountain range in which the mines of this district occur is isolated from all others, although evidently a part of a chain extending in a northwest and southeast direction for many miles. This particular group of hills is about 4 miles in length by $1\frac{1}{2}$ in width, and consists of rocks, which are all of plutonic origin. They are mostly quartz porphyry of the normal type, consisting of a fine-grained felsitic ground mass, with macroscopical crystals of quartz and feldspar.

Of several thin sections made for the purpose of microscopic study of these rocks, their behavior under the microscope is so similar that general description will suffice for all. The section is characterized by a micro-crystalline to micro-granular ground mass, sometime globulitic. The feldspars are so completely clouded as to leave little clue to their