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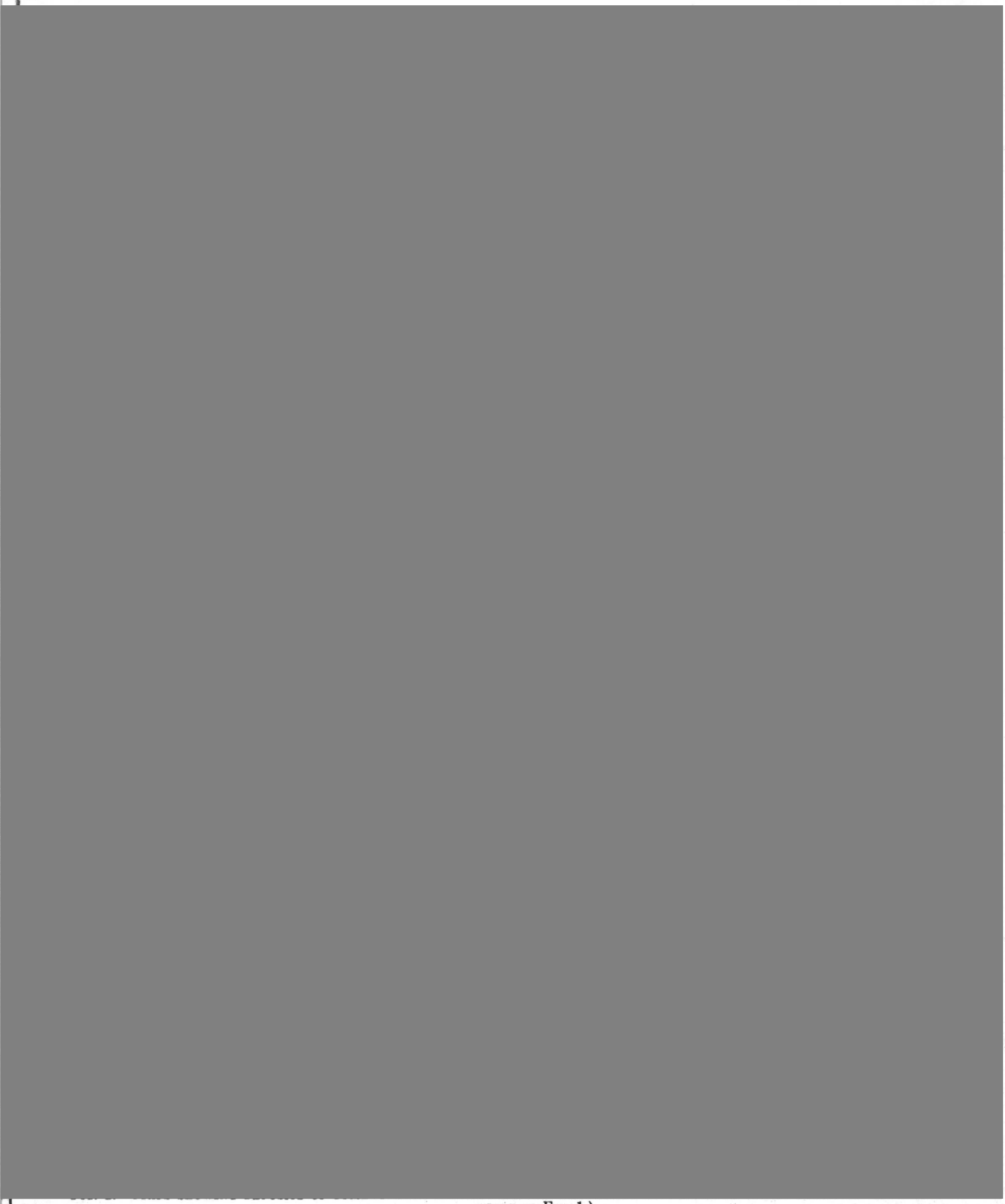
Transactions AIME 1927

Relations of the Disseminated Copper Ores in Porphyry to Igneous Intrusives

W. H. Emmons,* Minneapolis, Minn.

(New York Meeting, February, 1927)



SCALE AS FIG. 1.)

5. The outcrop, the leached and oxidized zone, and the zone of second-

[redacted]

[17] W. H. Emmons: *Op. cit.*

SOCIETY OF ECONOMIC GEOLOGISTS

THE PUBLICATIONS OF WHICH CONSTITUTE
A PART OF THIS JOURNAL

ECONOMIC GEOLOGY

VOL. XXXIII DECEMBER, 1938 No. 8

balance between gains and losses in the portions that have been

soda.

Analyses 7 and 8 from Lindgren, W.: Mineral deposits, 4th ed., p. 648. These are also in ECON. GEOL., XXI: 135–144, 1926.

Ore Genesis and Oreshoots

By Carlton D. Hulin
Assistant Professor of Geology, University of California

mining camps of North America and 24 important camps

IOWA GEOLOGICAL SURVEY

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

BULLETIN 397

MINERAL DEPOSITS
OF THE
CERBAT RANGE, BLACK MOUNTAINS, AND GRAND WASH CLIFFS
MOHAVE COUNTY, ARIZONA

BY
F. C. SCHRADER

WASHINGTON
GOVERNMENT PRINTING OFFICE
1909

The Estella prospect has six veins, which are mostly sm[illegible] some of the larger being about 2 feet thick. They strike mostly about N. 60° to 70° W. and dip steeply southwest. They consist principally of quartz and other oxidized material and are said to have produced good silver chloride ore, and some that contained values of $25 in gold to the ton.

The Estella-Bronco vein, to judge from the croppings, is about 4 feet thick and has an extent of at least 200 feet. It dips northeast at angles of about 80°. Its ore contains iron pyrites and green silver chloride. The vein of the Flora prospect is 20 to 30 inches wide. It dips about 30° NE., and contains two 3 to 5 inch streaks of oxidized galena ore, which is reported to average about $30 in lead to the ton. The deposit is associated with the contact of the aplitic intrusive with the older granitic rocks.

The Congress prospect, also known as the "Great Bronco," is situated in Mineral Park Wash, about three-eighths of a mile west of Mineral Park, mainly on the south side of the wash. It is owned by James Uncapher. It is a mineralized shear zone, or a fault zone, with an observed width of 300 feet and a reported width elsewhere of 600 feet. It trends N. 50° W., is in alignment with Ithaca Peak and Niggerhead, and is reported to be the same "ledge" on which the Queen Bee mine is located. It is probable that the Queen Bee and Pinkham veins and the Congress ledge are all associated in this locality, but their direct connection was not traced. The deposit occurs mainly in the granite porphyry at or near its contact with the pre-Cambrian complex. It consists of more or less silicified and in part altered and iron-stained gray porphyritic granite, with pyrite and chalcopyrite forming the principal part of the ore, disseminated more or less throughout. The deposit, where best exposed and opened in the wash by shallow workings extending more or less across it, is reported to average about $5 a ton in copper, silver, and gold. Here conspicuous patches and areas of malachite and azurite resulting from recent oxidation occur on the surface and basal slopes of the workings, and much of the surface diggings is stained yellowish and greenish. The deposit has received the consideration of some of the largest companies in the Southwest. Whether values will be found in depth seems doubtful.

The McDonald prospect, situated within a few hundred feet of the top of Cherum Peak on the south side, is on a ledge that dips steeply north and is reported to contain tungsten ore.

The Argo prospect, said to be located at an elevation of about 6,000 feet, is reported to have shipped some high-grade ore running from 200 ounces up in silver and containing good lead values.

The Swift claim is said to have produced and shipped some ore containing good values in gold, silver, and lead.

The ore shoot of the Sabbath [illegible] vein, opened b[illegible] 90-foot shaft, is reported to contain about 2 ounces of gold and 40 to 50 ounces of silver to the ton.

CERBAT DISTRICT.

GENERAL OUTLINE.

LOCATION AND HISTORY.

The Cerbat district extends southward from the Mineral Park district for about 4½ miles and from the border of Sacramento Valley on the west to the crest of the range on the east, with a maximum width of about 3 miles in the southern part.

Cerbat, the principal camp and post-office, is situated on Cerbat Wash in the foothills at an elevation of about 4,000 feet, 3 miles from the nearest station of the Arizona and Utah Railroad on the west and 14 miles north of Kingman. Its origin dates from the early sixties, when the Golden Gem, Cerbat, Idaho, Twins, Champion, Vanderbilt, Eureka, Flores, Esmeralda, and Columbus mines were discovered or opened. It has always been a producer of high-grade ore and is reported to have produced more than $2,000,000.

A small smelter was operated here in the so-called Indian days, in the middle of the sixties, but for want of proper fluxes, for which tin cans and scrap iron were substituted, the process was not very successful, the lead being turned out in an extremely crude state.

TOPOGRAPHY.

The district ranges in elevation from 3,000 feet in the foothills on the west to 5,000 feet on the east. Stockton Hill, on the opposite slope of the range, is reached by trail only. (See fig. 16.)

The southern part of the district is drained mainly by Cerbat Wash, which leads westward across the district into Sacramento Valley. Its principal tributary from the south is Charcoal Canyon, which is several miles long and joins it just below Cerbat.

The northern part of the district is drained principally by Long Wash, which leads northward and westward into Sacramento Valley. The nearest railroad station to this part of the district is Mineral, about 3 miles to the west. Several small depressions which open into Long Wash from the east are known as Union Basin, Todd Basin, and Lane Springs Basin.

GEOLOGY.

The country rock is the pre-Cambrian granite, gneiss, and schist complex. It is intruded by dikes of minette, granite porphyry, diabase, rhyolite, basalt, and other rocks, some of which are associated with workable veins and are too greatly sericitized for determination. The complex is also flanked on the west by masses of the Tertiary volcanic rocks, principally rhyolite.

Probably the best exposure in the Cerbat Range is in Charcoal Canyon southeast of Cerbat. The canyon cuts across the beds diagonally and exposes most of the pre-Cambrian rocks, including granite, gneiss, pegmatite, schists, and syenite, together with veins and dikes occurring in the complex. The series is cut by faults, some of which now contain ore bodies.

The schistosity strikes north-northeast, with dip mainly west-northwest, varying from 70° to vertical, and the jointing trends west-northwest, with steep dip to the northeast.

Prominent among the dikes is the well-known "great white dike," so called from the fact that it weathers light buff. It extends throughout the greater part of the canyon and is associated with workable ore deposits. It is 40 feet or more thick. It crosses Cerbat Wash near the mouth of Charcoal Canyon, underlies the Gross ranch to the northwest, and is reported to extend much farther. It is a dark greenish basic rock, which is now altered and sericitized beyond adequate determination. Though profusely jointed and sheared, it seems to be younger than the granite porphyry intrusives with which it comes into contact.

THE DEPOSITS.

The ore deposits of this district contain principally gold, silver, and lead. They occur in fissure veins, which in general have a northwesterly trend and a steep northeasterly or southwesterly dip. Those situated north of Cerbat Wash are chiefly gold-bearing; those to the south contain principally silver and lead. The gangue is mainly quartz and the values usually favor the hanging wall. The principal minerals are pyrite, chalcopyrite, galena, zinc blende, stibnite, and native gold. Near the surface native silver, horn silver, argentite, and ruby silver appear, but the water level is only about 80 feet deep, and consequently primary sulphide ore comes in at relatively slight depth.

The deposits are opened by about thirty mines, a sketch of some of which follows. The most important mines, nearly all of which are now producing, are the Golden Gem, Vanderbilt, Champion, Oro Plata, Paymaster, New London, Idaho, Cerbat, St. Louis, Flores, Twins, Columbus, Alpha, Night Hawk, and Rip Van Winkle.

MINES NEAR CERBAT WASH DRAINAGE ON THE NORTH.

GOLDEN GEM MINE.

Location, history, and production.—The Golden Gem mine is located at Cerbat, on the hillside which slopes to the west. The mine was discovered and began to ship ore in 1871. Subsequently it lay idle for some time until it was acquired by T. L. Ayers, who shipped a very large amount ($200,000 reported) of rich (5-ounce) gold ore. He also hauled some of the ore to the C. O. D. mill, and left over

2,000 tons of second-grade ($24 ore on the dump, much of which still remains. Later the property was bonded to the Golden Gem Mining Company, of New York, of which Senator Warner Miller was president. This company sunk the shaft deeper and drifted, but as the ore on the 300-foot level fell off in grade, the mine was closed in 1904. It remained idle until 1906, when it was sold for $75,000, and is now owned by the Golden Star Mining and Milling Company.

A 40-ton mill with four Nissen stamps, recently installed, is now daily turning out about $350 worth of concentrates from the ore formerly left on the dump. Twenty per cent of the gold is collected on the plates. Preparations are being made to unwater and retimber

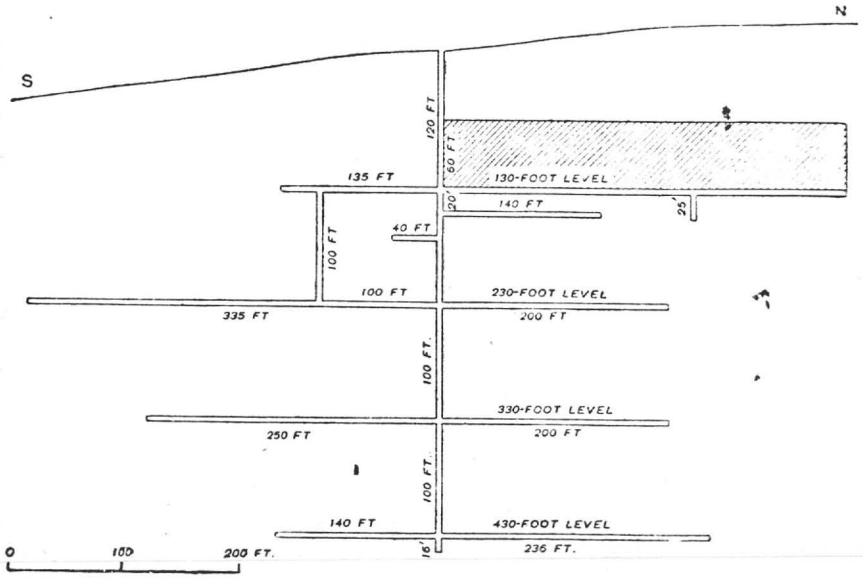


FIGURE 13.—Longitudinal section showing development of Golden Gem mine.

the old shaft of the mine, which at the time of visit was filled with water to the 200-foot level. This mine has produced good ore from the surface down, and the total production is said to have amounted to $190,000.

Development.—The mine is developed principally by a two-compartment shaft, 435 feet deep, and four levels containing about 1,200 feet of drift, winzes, and stopes. The levels are located at 130, 230, 330, and 400 feet below the surface. The first level contains 350 feet of drift north and 135 south from the shaft; the second level 200 north and 355 south, the third level 200 north and 200 south, and the fourth level 246 north and 140 south. (See fig. 13.) The only stopes are on the 130-foot level. They extend 66 feet horizontally and from 62 to 81 feet vertically.

The principal surface equipments are the 40-ton mill above mentioned, a 34-horsepower hoist, and distillate engines, aggregating 79 horsepower, for operating the plant.

Geology and ore deposits.—The country rock is the pre-Cambrian granite, gneiss, and schist complex. Fine-grained iron-gray gneissoid schist usually forms the hanging wall of the vein. The structure trends north-northeast and the rocks are intruded near by by diabase and granite porphyry or monzonite porphyry dikes. The much-altered diabase occurs in association with the vein.

The vein strikes about N. 40° W. and dips about 78° NE. It ranges from 6 to 14 feet in width and usually carries from 2 to 6½ feet of pay ore running from $10 to the ton upward. The ore shoots are reported to be more regular in the deeper part of the mine than near the surface.

The gangue is chiefly quartz and altered rock and is imperfectly banded. Some of the quartz is similar to the Gold Road type described on page 158. The ore contains chiefly gold, but carries also silver in places as high as 60 ounces a ton. The ore minerals are galena (5 or 6 per cent), zinc blende, pyrite, and stibnite. The vein is banded and shows evidence of intradepositional faulting. The values usually favor the foot wall, but vary in position, and locally rich ore streaks 2 feet wide occur on both sides of the vein.

Southeast of the mine the vein is about 6 feet in width and, as shown by croppings, extends about one-fifth of a mile to Cerbat Wash, where there are some indications that it may be split. So far as opened in the mine and two surface prospects beyond, the ore is reported to run about $20 to the ton.

On the 130-foot level, 270 feet northwest of the shaft, the vein is faulted off diagonally along the schistosity on the south or foot-wall side of a 4-foot band of dark schist. The ore shoot from the shaft to this point looks well and is reported to average high in gold.

The face of the drift extending south of the shaft on this level is reported by the foreman who had charge when the mine was suspended to contain a 24-inch streak of $48 ore.

VANDERBILT GROUP.

General description.—The Vanderbilt group comprises the Vanderbilt, Idaho, and Columbus mines, situated near together in the foothills at Cerbat, just north of the Golden Gem mine. The group is owned by the Cerbat Mining Company, with headquarters at St. Louis. At the time of visit the company was installing a 25-ton mill to treat the low-grade ore from the upper part of the mines by calcination and amalgamation of the concentrates, there being a large

amount of low-grade ore, especially in the Vanderbilt. The ore from the lower levels, owing to its richness, is shipped direct to the smelter.

Vanderbilt mine.—The principal mine of the group is the Vanderbilt mine, located about half a mile northwest of the Golden Gem and a little above it, near the head of Flores Gulch, which drains westward into Sacramento Valley. The Vanderbilt is one of the oldest mines in the camp. It was located early in the sixties and is now producing. It is developed principally by a 300-foot shaft and 800 feet of drift and crosscuts.

The country rock (locally called syenite) is pre-Cambrian fine-grained gneissoid chloritic schist, and is probably derived from a diorite which has been greatly sericitized and otherwise altered. Associated with the vein on the foot-wall side is a "porphyry dike," which may represent the intrusive granite porphyry.

The deposits occur in a fissure vein, which, like the Golden Gem vein, dips about 80° NE. and is supposed to represent the northwestward continuation of the Golden Gem and Idaho veins beyond their point of junction.

The ore, as in the Golden Gem mine, contains chiefly gold values, but carries silver also. The ore minerals are pyrite, zinc blende, and stibnite. The ore occurs mainly on the hanging-wall side. The best grade is reported to average about $500 or more to the ton. Galena occurs from the surface down to the 200-foot level, below which no lead ore has yet been found.

From the upper levels the mine is reported to have produced $150,000, and it has also yielded considerable ore to the present company.

Idaho mine.—The Idaho mine is located at Cerbat, near the Golden Gem mine, on slightly lower ground in a gulch on the west. It is one of the early discoveries of the camp, its ore being worked by Mexicans in arrastres during pioneer days, and it has been worked in a small way since 1871. It is developed principally by a 110-foot shaft sunk on the vein and 275 feet of drift. The shaft is reported to be wholly in ore and to show in the bottom a width of 5 feet of solid ore, which averages about $20 to the ton.

The geology and the ore are similar to those of the Golden Gem mine. The vein strikes N. 20° E. and dips 80° E. It averages about 4 feet in width and its ore shoot about 2 feet. The ore contains principally gold, with some sulphide of silver, galena, pyrite, and a little chalcopyrite. The production is reported to be $250,000.

Columbus mine.—The Columbus mine is about one-fourth mile northwest of the Vanderbilt mine, near the upper side of Flores Wash. The deposits are contained in a fissure vein, which has been opened principally by two shafts reported to be 175 and 200 feet deep and by 500 feet of drift. The production is said to be several hundred tons of rich ore.

ROBERT EMMET MINE.

The Robert Emmet mine, situated north of the Vanderbilt mine, is reported to be on a large vein, which is said to contain good values in gold and to have been a producer of rich gold ore.

FLORES MINE.

The Flores mine is located in the foothills on the upper part of Flores Wash, a short distance below the Vanderbilt and Columbus mines, northwest of Cerbat, and about 700 feet above Sacramento Valley. The property comprises a group of four mining claims.

The mine was first located in 1871 by a party of prospectors from Nevada, but owing to the hostility of the Indians actual mining did not begin until 1875 or 1876. At one time the mine was known as the Five Forks mine, from the ramification of the north end of the vein into five parts.

One of the early operators was Charles M. Gross, sr., a resident of Mineral Park, who afterwards became owner of the mine. In 1888 it was acquired by the Flores Mining Company, of Philadelphia. This company at once installed a 14-ton double-rocker mill, hoist, and other machinery and worked the mine until 1893, when, owing to financial difficulties, the mine was closed and sold for taxes. It was bought by W. N. Gurley, whose widow still owns it. The mine has not been operated since 1893, and is now filled with water to the 100-foot level.

The mine is reported to be developed to a depth of about 300 feet, with but little stoping. The principal surface equipments are a 5-stamp mill and a steam hoist. The mill is equipped for fine crushing and amalgamating, as the ore contains free gold.

The production is reported to have been considerably more than $200,000.

The country rock is the pre-Cambrian granitoid schist, and the intrusive granite porphyry seems to be present near by. The deposit is in a fissure vein about 4 feet thick, which dips 80° to 85° NE., but at the surface, where the vein is crosscut by Flores Gulch, it locally dips in an opposite direction. The croppings are chiefly reddish and brown iron-stained quartz and crushed or brecciated rock.

Though some ore averaging as high as $1,000 to the ton has been produced, the ore is mostly of too low grade to ship. It is contained in an oxidized gangue, composed chiefly of quartz and altered rock.

The ore contains gold, with silver sulphide, some zinc blende, and galena. It favors the hanging-wall side of the vein. Mr. Gross is reported to have handled ore averaging $60 or more only, but the Flores Company, with the mill now on the ground, profitably handled ore ranging as low as $6 a ton.

ESMERALDA MINE.

The Esmeralda mine is located in low, gently rolling foothills about a mile west-northwest of Cerbat, at an elevation of about 3,750 feet. It is owned by the Ark and San Antonio Mining and Milling Company, of St. Louis. It is developed principally by a 200-foot shaft and two levels containing about 250 feet of drift, with some stoping near the surface. The 110-foot level extends 90 feet south and 30 feet north of the shaft. At the time of visit the shaft contained water. The principal equipment is a 10-horsepower steam hoist.

The production is reported to be $90,000.

The country rock is the pre-Cambrian complex, with schistose structure trending about N. 35° W. The rock is intruded near the mine on the northeast by a fine-grained granite porphyry dike, several hundred feet in width.

The deposit is a fissure vein, which strikes N. 35° W., parallel with the schistosity in the country rock, and dips about 75° SW. The vein is from 4 to 5 feet in width. Its gangue consists mainly of quartz and crushed and more or less altered country rock. Oxidation extends to the depth of 90 feet below the surface, below which the ore consists of sulphides and contains chiefly pyrite and chalcopyrite, with gold and silver. A carload of the concentrates that was shipped is reported to have averaged 13.42 ounces of gold and 40 ounces of silver to the ton. The ore usually shows a crude banding about parallel with the vein.

CERBAT MINE.

The Cerbat mine is about a mile northeast of Cerbat, and the Golden Gem mine, in the foothills, on a side gulch of Cerbat Wash and near the top of the ridge separating it from Long Gulch on the north, at an elevation of about 4,600 feet. This mine is one of the early discoveries. Two operators were killed in it by the Indians in pioneer days. It was opened in 1869 and was worked by a whim in 1875. About 1880 a large mill was installed in the gulch below the mine, but operations have now been suspended for some time. The mine is owned by the Cerbat Mining and Milling Company, of Minneapolis. It is credited with a production of about $300,000.

The mine is developed principally by a 180-foot shaft, drifts, and stopes. The principal surface equipment is the large mill above mentioned.

The deposit forms a fissure vein 4 to 10 feet wide, contained in the pre-Cambrian complex. The vein strikes north-northwest, with bold croppings locally rising 8 or 10 feet above the surface. The gangue is mostly quartz, with some crushed and recemented rock. The ore

contains chiefly gold, with silver and copper also. The copper occurs mainly in the form of chalcopyrite and carbonates. A conspicuous coating of malachite is now forming on the ore walls and surface of the workings in the mine. Most of the rich ore seems to have been taken out, but the mine is reported to contain a large amount of good milling ore.

BUNKER HILL MINE.

The Bunker Hill mine is located in the mountains, a short distance east of the Cerbat mine. It is owned by John Mulligan. It is said to contain two veins situated close together. The ore, some of which has been shipped to the Needles smelter, is said to contain high values in gold and copper.

MINES IN UNION BASIN.

Union Basin, comprising an area about 1 mile in diameter, is located northeast of the Cerbat mine, in the upper part of Long Wash, which heads to the north of the upper part of Cerbat Wash. The nearest railroad station is Mineral, 5 miles distant, reached by wagon road descending Long Wash. The basin contains about a dozen small mines and prospects, not all of which were visited. The most important are described in the following paragraphs.

PAYMASTER MINE.

The Paymaster mine is located in the southern part of Union Basin, at the head of Long Wash, about half a mile north of the Cerbat mine, at an elevation of about 4,500 feet. It is an old mine and was profitably worked in the seventies, when the cost of mining supplies and of the reduction of ore was many times what it is now. It is owned by the Victor-Paymaster Mining Company, of Los Angeles, and is now producing. The total production is reported to be about $200,000.

The mine is developed principally by a 230-foot 60° inclined shaft and about 1,200 feet of drift, with upraises and stopes. It produces considerable water. The principal surface equipments are a steam hoist and a pump. At the time of visit a gasoline hoist and new machinery were being installed for more expeditious work.

The vein is contained in the pre-Cambrian complex, strikes N. 70° W., and dips 75° NNE. Locally it attains a width of about 15 feet. The gangue is chiefly mineralized quartz, in which the ore occurs principally in shoots, ranging from 16 to 24 inches in width.

The quartz contains principally silver values, with some gold. Much of the silver is in the form of ruby silver. The ore is said to range from $50 a ton upward. Some of it contains about 500 ounces of silver to the ton.

ALEXANDER GROUP.

The Alexander group of mines is located just northeast of the Paymaster mine, on northwestward slopes between 4,400 and 5,000 feet in elevation. It comprises four claims, the Alexander Nos. 1 and 2, Lazy Man, and Granfield. The two former are situated on the same vein and the two latter on separate veins. The veins were discovered in 1880 by Captain Lane, of Lane Springs Basin, and located in 1890 by James Dundon, of Cerbat, who is the present owner. The production of the property is reputed to exceed $5,000, the main part being derived from Alexander No. 1 claim.

The Alexander No. 1 is developed by three shafts and drifts. The shafts are 60, 80, and 230 feet deep. The shaft of the Alexander No. 2 is 100 feet deep. The Lazy Man contains a tunnel 125 feet in length, and two small shafts. On the Granfield claim the vein is opened by two inclined shafts, 35 and 100 feet deep and 500 feet apart.

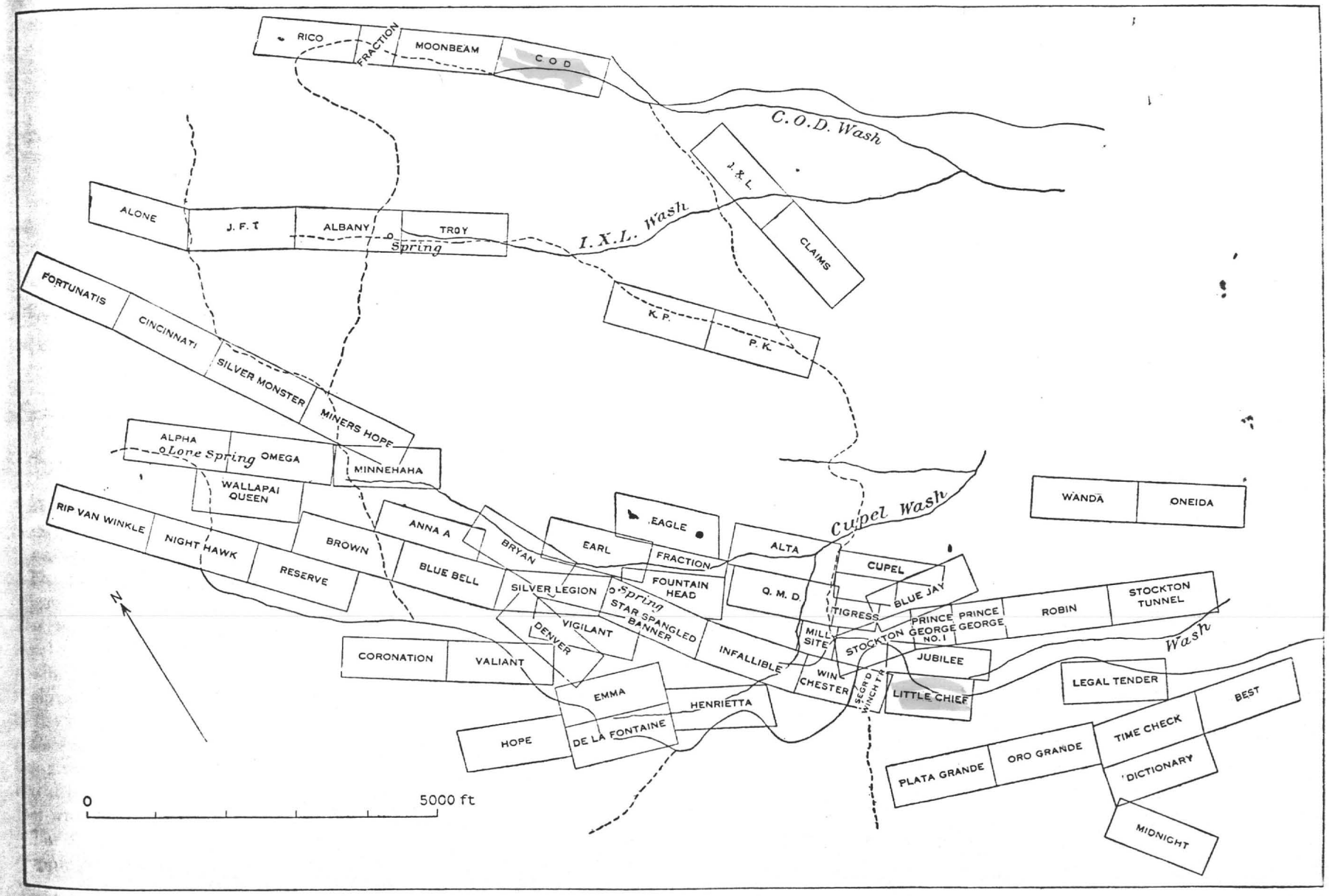
The country rock is the pre-Cambrian gneiss complex. The veins strike northwesterly and dip northeasterly at angles of 60° to 80°. They range from 2 to 4 feet in thickness and are oxidized down to water level, which lies at about 80 feet below the surface.

The gangue is mainly kaolin, with some quartz. It is hard in the oxidized zone, but soft below water level. The ore usually favors the hanging wall and is said to occur in a nearly continuous shoot, about 18 inches in width. It contains silver, gold, iron, and lead. In the oxidized zone it contains principally soft horn silver and gold, with a little oxide of iron and carbonate of lead, the silver in places averaging about 500 ounces to the ton. Below water level the ore is chiefly sulphide, the lead occurring in the form of galena and the iron as pyrite, and there is reported to be an increase in the amount of silver, with little or no decrease in the amount of gold.

OTHER MINES.

The Climax mine is located on rough ground in the eastern part or head of Union Basin. It formerly belonged to James Dundon, of Cerbat, who recently sold it to a stock company of Denver. It is developed by several shallow shafts and drifts. The vein dips steeply southwest or is nearly vertical. The sulphide ore contains gold, silver, pyrite, chalcopyrite, and galena. The values are chiefly in gold and silver.

The Silver, Eddy, and Tub mines are said to be located on the same vein or lode, which in the Silver mine attains a width of about 100 feet. The Silver mine, owned by James Mulligan, is said to be developed mainly by shallow shafts and several hundred feet of drift. The ore is of low grade, containing principally gold and silver values, and is said to concentrate well.



CLAIMS IN STOCKTON HILL DISTRICT.

According to reports the Tub mine is developed principally by shafts and crosscuts. Here the vein varies from 30 to 80 feet in width and widens downward. It is reported to show at a depth of 40 feet a 4-foot streak of galena, containing values in gold and silver, and at 60 feet below the surface an ore body about 20 feet in width, which averages about $10 in gold and 20 ounces in silver to the ton, and contains zinc, copper, and lead. The mine is known to have produced several hundred tons of lead carbonate ore, most of which averaged about 40 per cent of lead.

The Big Bethel mine is reported to be situated on a large vein containing a shoot of high-grade ore and is credited with a production of $10,000.

The Golconda mine, owned by E. F. Thompson and E. B. Smith, is opened by shaft, tunnel, and adit drift. It is reported to have produced from essentially surface workings several hundred tons of rich ore containing chiefly gold, silver, and lead values, with some copper and zinc. Some of the ore was treated at the old Empire mill in Todd Basin with good results. Recently the 300-foot level is reported to have been driven 200 feet on a 4-foot ore shoot that assays 50 per cent of zinc.

The Green Linnet mine is said to be opened principally by a 100-foot shaft and about 500 feet of drift and to have a good showing of ore.

Some of the mines of Union Basin are now said to be shipping ore to Iola, Kans., and Oklahoma for treatment. The ore is reported to average about 50 per cent of zinc, and to contain good values in gold and silver.

MINES IN TODD BASIN.

Todd Basin, a valley about 2 miles long, is situated immediately north of Union Basin and, like it, drains westward into Long Wash. The topography is generally rugged. The mines described in the following notes are the most important in this locality.

ORO PLATA MINE.

The Oro Plata mine, one of the heaviest and most continuous producers, is located in the eastern part of the district near the axis of the range and the head of the main gulch, at an elevation of about 4,300 feet. It is reached by wagon road. The mine was first located and owned by Mexicans, under whom it began to be worked early in the seventies. It was next owned by J. P. Lane, whom the tailings are said to have netted $70,000, but who, in 1882, sold it to a party of ranchers under the lead of H. Wilson. These men worked it and shipped ore to the smelters in Colorado, and finally sold the mine to J. W. Garret in 1895. In 1897 and 1898 the mine produced $150,000. Recently it has been purchased by the Oro Plata Mining Company, of St. Louis.

The mine is developed to a depth of 280 feet, principally by shafts, drifts, adit drifts, tunnels, and stopes, aggregating, it is said, about 7,000 feet of underground work distributed on three levels. The mine produces considerable water, ample for all milling purposes. The principal surface equipments are a 20-horsepower steam hoist and an air compressor. At the time of visit ground was being broken for a new mill.

The country rock is the pre-Cambrian gneiss, extensively intruded by coarse granite porphyry, a large dike of which crosses the gulch just below the mine. In the mine the granite porphyry seems to be associated with the vein, as does also a large 40-foot dike of finer-grained granite porphyry.

The vein, about 4 feet in width, normally dips about 80° NE. It is locally enriched by intersection with another vein. (See fig. 14.)

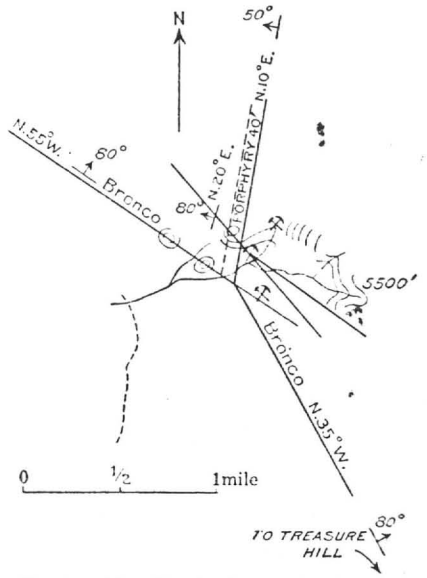


FIGURE 14.—Sketch showing relation of veins at Oro Plata mine.

The ore, which occurs chiefly in a banded quartz gangue, contains principally gold and silver. There are small amounts of chalcopyrite, zinc blende, pyrite, and galena. The ore shoots are said to be richer and more regular in the deeper part of the mine than near the surface. The ore averages in gold 3 ounces and in silver 25 ounces to the ton, and in lead about 6 per cent. There is said to be good ore in the bottom of the mine, which carries about 7 per cent of lead. The value of the output of the mine from July 14, 1896, to February 18, 1901, as shown by the sheets of the Arizona Sampler Company, which bought the ore at Kingman, was approximately $206,000 (2,527 tons of ore, averaging $80 to the ton), of which about 75 per cent was in gold and the balance in silver and lead. The price paid in the recent purchase of the mine was based on the assumption that the ore on the whole averages $37 to the ton, including the large bodies of moderate-grade ore left in the mine above the 280-foot level during earlier work.

The total production is reported to be about $500,000, and about 5,000 tons of second-class ore, said to average about $20 a ton, lie on the dump.

PROSPERITY MINE.

The Prosperity mine adjoins the Oro Plata mine, being located on the same vein where it ascends the mountain slope on the southeast. It was formerly owned by Cal. Wright and J. P. Lane, but is now owned by Owen McNally. It is said to be developed by about 700 feet of drift, mostly adit. The ore contains principally silver. Near the surface an ore body 9 feet in width is reported to have been a large producer and to have yielded considerable ore, which averaged $220 to the ton.

PRIMROSE MINE.

The Primrose mine almost adjoins the Prosperity mine on the southeast. It is owned by G. M. Bowers and T. E. Pollock. It is developed mainly by an adit drift, the breast of which is said to be in good ore, containing gold, silver, and copper. The mine produces much water and will require the installation of machinery for deep sinking.

BLACKFOOT MINE.

The Blackfoot mine, said to have been a good producer, is southeast of the Primrose mine, near the head of the gulch. It is owned by Byron Collins and Owen McNally. It is said to be developed principally by tunnels and shafts to the depth of several hundred feet. A proposed lower tunnel would cut the ore bodies at about 100 feet below the present workings. The vein is said to pinch in places, but in general increases in width with depth, and the ore shoot varies from 6 to 24 inches in width. The ore is reported to contain gold, silver, and copper, some of it running 180 ounces of silver and 3 ounces of gold to the ton and about 15 per cent of copper.

SUCCESS MINE.

The Success mine, located near the Oro Plata, is said to be opened by tunnels, drifts, and shafts on the vein. The ore is said to be sulphide and contains gold, silver, and lead. A lot treated years ago in the old mill in Todd Basin is said to have netted $27 a ton.

MEXICAN MINE.

The Mexican mine, located in the eastern part of the basin, is reported to have produced considerable ore that averaged about 9 ounces of gold and 312 ounces of silver to the ton.

MINES IN LANE SPRINGS BASIN.

Lane Springs Basin is a short, deeply cut side valley situated northeast of Todd Basin, from which it is separated by a prominent spur-like ridge extending northwestwa[illegible] from the axis o[illegible] range. The basin contains six or eight mines, of which those described below are the most important.

ALPHA MINE.

The Alpha mine is located in the eastern part of the basin, at an elevation of about 5,000 feet. It is owned by Peter Cooper, Oscar F. Dennis, and Mrs. Smith. It is developed principally by two drifts, the upper one 400 feet and the lower one 200 feet in length, both of which trend about S. 30° E. along the vein, almost directly across the strike of the pre-Cambrian gneiss complex. The croppings are a prominent reef of black, iron and manganese stained quartz. The vein varies from 4 to nearly 20 feet in width, and consists principally of a gangue of imperfectly banded, fine-grained, sulphide-bearing quartz, in which the ore occurs. The ore contains silver sulphide, pyrite, galena, zinc blende, and chalcopyrite.

The mine is reported to have been a good producer. A consignment of 400 tons of ore is reported to have netted $125 a ton.

NIGHT HAWK AND RIP VAN WINKLE MINES.

The Night Hawk and Rip Van Winkle, two adjoining mines, are situated about half a mile southeast of the Alpha mine, both on the same vein in the steep northwest slope of the mountain, at an elevation of about 5,000 feet. The country rock is pre-Cambrian gneiss. The vein strikes northwesterly. In the Night Hawk it is reported to be developed principally by a drift 1,400 feet in length, whose face is located about 700 feet beneath the apex of the vein. The vein is said to be large and to contain a "pay streak" of sulphide ore ranging from 6 to 18 inches in width. The ore shoot in two localities has feathered out, and in both has been recovered with its usual values by cross-cutting into the foot wall. Much of the ore is rich; some of it is reported to have averaged $2,000 a ton in carload lots. According to record sheets of the Sampler Company, who bought most of the output from April, 1887, to January 20, 1900, the ore averages about 3 ounces of gold and 300 ounces of silver to the ton; the production during this period was 464 tons, containing values of about $244 a ton, amounting to about $113,000. The total output of the mine is reported to be $150,000, and was produced at intervals during the last seventeen years.

MINES SOUTH OF CERBAT WASH.

The principal mines situated south of Cerbat Wash are the Champion, New London, St. Louis, and Twins. As stated elsewhere, they contain chiefly silver and lead.

CHAMPION MINE.

The Champion mine is 1¼ miles southwest of Cerbat, on the west front of the range, 600 feet above and about three-fourths of a mile distant from Sacramento Valley, at an elevation of about 4,100 feet, near the head of a short wash that leads westward into the valley. It is reached by wagon road from the west. This mine is one of the early discoveries. It was fromerly worked by James Dundon, but is now owned by the Arizona-Mexican Mining and Smelting Company, of Needles, Cal. It is producing at a moderate rate. The mine is developed mainly by shafts and about 600 feet of drift to a depth of 70 feet, and it produces a little water.

The country rock is the pre-Cambrian gneiss, and it is intruded near the mine by granite porphyry and by diabase and minette dikes.

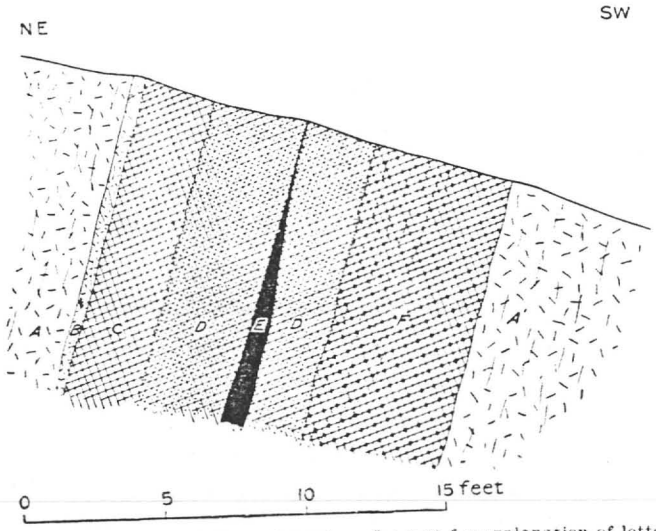


FIGURE 15.—Section of Champion vein. See text for explanation of letters.

One or more dikes are associated with the vein, which is about 12 feet in width and dips steeply to the northeast. A cross section of the vein, as sketched at the mine near the surface, is shown in figure 15. In this figure A represents country rock, consisting of alternately dark and light streaked granitic schist forming the hanging wall; B is gouge consisting principally of crushed granitic rock; C is brown, iron-stained ore; D is dark, earth-colored, fresh dike rock, which seems to be minette and contains biotite, augite, orthoclase, and andesine; E is a stringer of quartz and brown, iron-stained carbonate ore material, which widens at about 60 feet back from the face and is reported to have carried an ore shoot 1 foot in width, which, in the deeper part of the mine, becomes the main vein; F is reddish, coarse granite, or pegmatite, composed mainly of feldspar,

and toward D is sheared and cut by parallel lines produced by movement; A′ is dark granitoid schist, about the same as A, forming the foot wall. The ore is composed mainly of sulphides and contains principally lead, gold, and silver, the gold in some of it running about an ounce to the ton.

The mine has produced a large amount of ore, a considerable portion of which was high-grade surface ore. It now produces about 6 tons of ore a day, four-fifths of which is shipping ore. Only the best ore is mined. A large amount of milling ore is left in the mine and a considerable amount also lies on the dump.

NEW LONDON MINE.

The New London mine is located at the west base of the range, about one-fourth mile southwest of the Champion mine, at an elevation of about 3,800 feet, in an open wash, but little above the level of the neighboring Sacramento Valley. The mine was worked during the middle eighties, at which period it produced much good ore. It was closed about 1893 and is now dismantled of all surface equipments, but is regarded as a good property. The owners are Skee Brothers, of Santa Monica, Cal.

The mine is reported to be developed principally by two inclined shafts, drifts, and stopes. Though the deepest shaft is 150 feet in depth, the work is nearly all comprised between the 75-foot level and the surface and in a horizontal extent of 400 feet.

The vein containing the deposits is said to be similar to that of the Champion mine, but stronger, and to contain large bodies of ore. It strikes about N. 60° W. and dips 55° NE. The ore is said to average high in silver and gold, as well as in lead.

TWINS MINE.

The Twins mine is about one-fourth of a mile east of the Champion mine, in Twin Gulch, which trends northward and joins Cerbat Wash below the mouth of Charcoal Canyon. It is owned by the same company as the Champion mine, described above. It is opened by shafts and drifts to a moderate extent. It may develop into a zinc mine, for in the bottom of the mine the vein contains a shoot of zinc blende about 5 feet in width, which also contains from $7 to $8 a ton in gold. The mine is reported to have produced 300 tons of ore, aggregating a value of $10,000.

ST. LOUIS MINE.

The St. Louis mine is about half a mile east of Cerbat and the Gem mine and the same distance southeast of Cerbat Wash and several hundred feet above it. It is accessible by wagon road. The mine was discovered about 1865. It has been a producer on a

moderate scale, and is now producing under the present own[illegible] the St. Louis Consolidated Mining and Milling Company, with headquarters at Los Angeles. This company acquired it in 1905. The property comprises 19 claims, but the developments are chiefly on the St. Louis Claim.

The mine is developed principally by adit drifts and tunnels, mostly within a vertical range of 340 feet, and contains about 1,000 feet of underground work. The shaft on the Knocker claim, however, is reported to be 110 feet deep.

Five distinct veins are reported to occur in pre-Cambrian gneiss. Several of the veins are said to converge near the southeast end of the St. Louis claim. Three of the veins trend northwest and dip 80° NE., and two trend about north and south and dip 85° E. The hanging wall of all the veins is said to be gneiss. The north-south veins are reported to have in most places a "porphyry" foot wall. These veins average about 5 feet in width and are said to be richer than the northwest-southeast veins and to contain more silver. The richest ore they contain is said to be steel galena. The ore occurs in shoots or bunches varying from 2 to 16 inches in width. It contains about $3 in gold and 12 ounces of silver to the ton and 55 to 75 per cent of lead.

The northwest-southeast veins are said to have a dark rock on the foot wall, with gneiss occurring locally on each wall. The largest of these veins is said to be 4 feet in average width, but it carries less ore than the smaller veins.

The two veins now being worked are known as Nos. 2 and 3. They are about 3 feet wide and the ore varies from 4 to 16 inches in width. In carload lots the ore is said to average about 60 per cent of lead and $2 in gold and 14 ounces in silver to the ton. Most of the ore thus far produced has been obtained within 40 feet of the surface. The management is now taking out shipping ore only and doing development work.

BLANKET VEIN PROPERTY.

The Blanket Vein property is about half a mile southwest of the Gem mine, just below the mouth of Charcoal Canyon. It is principally owned by the Golden Star Mining and Milling Company. The deposit is a gold-bearing quartz vein, resting on pre-Cambrian granite. It dips northeasterly at the low angle of about 30°, and is unique in being now bared, the granite having been completely removed from the upper surface by erosion over a nearly equidimensional area of about 500,000 square feet.

The vein is about 1 foot in average thickness and is said to contain about $8 in gold to the ton, or a total value of more than $90,000 for the area of the deposit thought to be in sight. Hornings and assays

show portions of the deposit to co[illegible]in as high as $[illegible]n gold to the ton. The gold is mostly free milling. The quartz also contains some iron, principally hematite and limonite, derived from pyrite by oxidation.

STOCKTON HILL DISTRICT.

GENERAL OUTLINE.

LOCATION AND HISTORY.

The Stockton Hill district joins the Cerbat district on the east, and is about parallel and coextensive with it north and south, being situated on the opposite slope of the mountains. It is about 4 miles in width and but little more in length. It ranges in elevation from 3,500 feet at the edge of Hualpai Valley on the east to 5,500 feet at the crest of the range.

The principal and oldest camp is Stockton Hill, situated in the foothills in the eastern part of the district, 10 miles north of Kingman, at an elevation of about 4,800 feet. It dates from early in the sixties, when the principal veins were first discovered and began to produce. In former days much of the ore was shipped to Swansea, Wales, but later it was treated in the Mineral Park and Cerbat mills and shipped to the smelters in San Francisco and to New Mexico. At present the ore is hauled by wagon to Barry or Kingman, whence it is shipped, mostly to Needles. The district is reported to have produced many million dollars' worth of ore.

TOPOGRAPHY AND GEOLOGY.

The topography, shown in part in the sketch map (fig. 16), is generally rough, but the mines are nearly all accessible by wagon roads, mostly of easy grade. The drainage issues eastward into Hualpai Valley, mainly through several short side valleys or transverse washes—the Canyon Station, C. O. D., I. X. L. (known as I. X. L. Basin from the width and open character of its middle part), Cupel, Treasure Hill, and Maywell. In their upper parts most of the washes contract into V-shaped gulches.

The country rock is the pre-Cambrian gneiss and schist complex. It is reddish brown and iron stained and is intruded by dikes of granite porphyry, diabase, and other rocks, mostly of basic character. The schistosity trends about N. 30° E. and dips usually vertically or at steep angles to the northwest. The dominant jointing or sheeting strikes northwest.

ORE DEPOSITS AND MINES.

The deposits occur in pre-Cambrian gneiss or schist, intruded in places by a later aplitic granite or by basic dikes. They are fissure

veins, which in general strike northwesterly and are vertical or dip at steep angles to the northeast. The gangue is quartz and the ores contain chiefly silver, with some gold, lead, and copper. Primary sulphide minerals are galena, zinc blende, chalcopyrite, and pyrite, but the district owes its reputation to the rich silver ores, such as native silver, cerargyrite, argentite, and ruby silver, which were found in large quantities in the upper levels. The water level is about 100 feet below the surface. Galena is often found above it, while rich silver minerals descend to a considerable distance below it. The greatest depth attained is 400 feet.

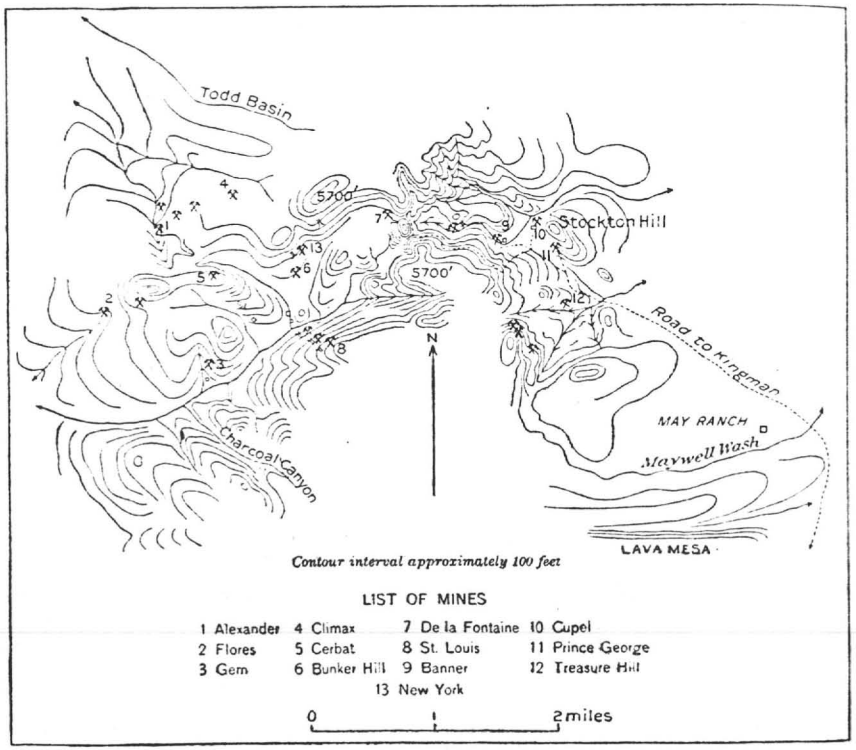
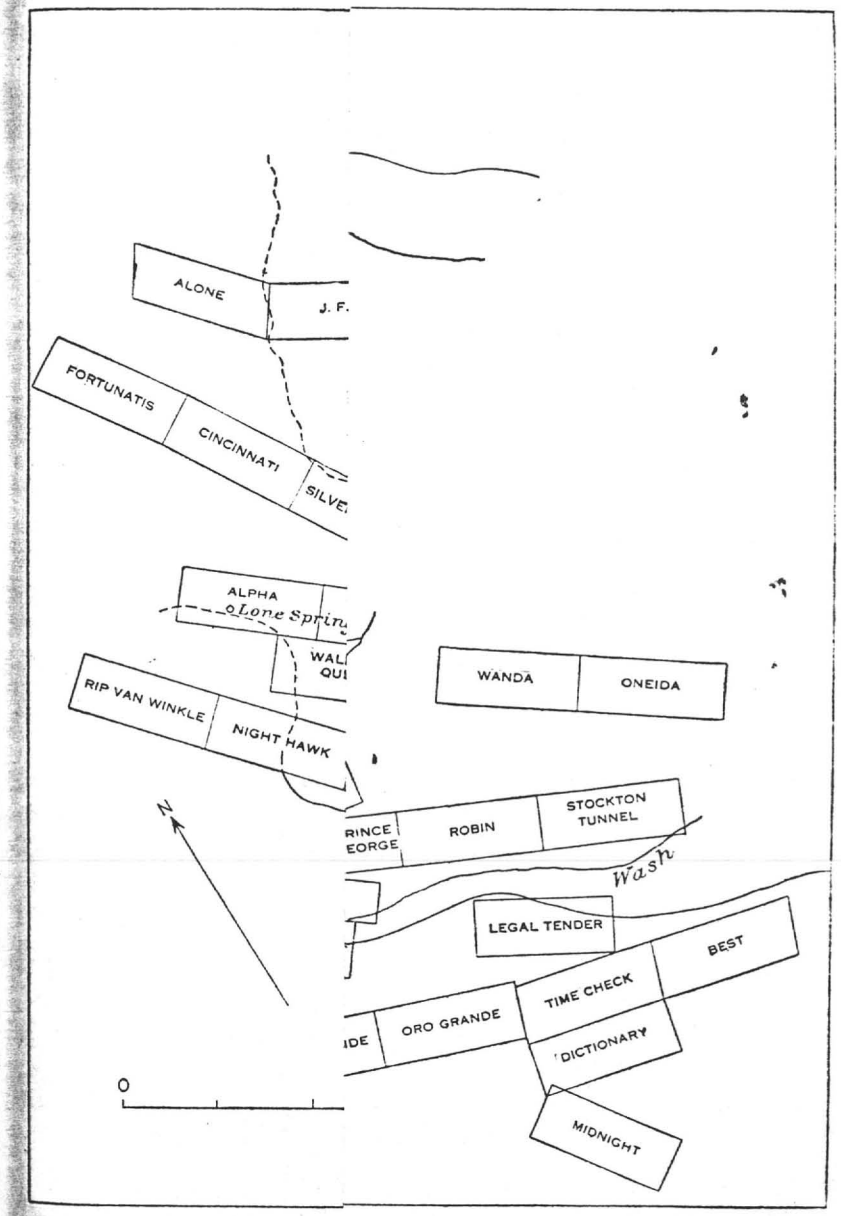


FIGURE 16.—Sketch map of Stockton Hill district and adjoining part of Cerbat district.

The district contains about 10 mines, of which the principal are the Banner Group, Treasure Hill, Little Chief, Cupel, Prince George, De La Fontaine, C. O. D., and Sixty-three. Their general distribution is shown on the accompanying sketch map (fig. 16). The principal locations made in the district are indicated on the claim map (Pl. VIII).

MINES ON STOCKTON HILL WASH.

The principal mines on or near Stockton Hill Wash are the Banner Group, Cupel, and De La Fontaine. Their situation in alignment on a nearly east-west line about 1½ miles in extent has led to the



current belief that they are all on the same vein. They are perhaps in a general way in the same mineral zone, but as the strike of the veins at the different mines does not coincide with the trend of the mines and the veins have not been traced and do not seem to connect from mine to mine the single-vein theory remains to be proved.

BANNER GROUP MINE.

Location.—The Banner Group mine (Pl. VII, *B*) is about half a mile west of Stockton Hill, near the center of the district, toward the upper or gulch part of Cupel Wash at a point where it widens into a small basin at about 4,800 feet elevation. The property is said to comprise six adjoining claims, of which the most important are the Infallible (formerly Indian Boy) and the Star Spangled Banner. The principal mine openings are on the former, whence the workings extend northwestward into the latter. The property is owned and operated by the Arizona-Mexican Mining and Smelting Company, of Needles, Cal., where the large smelter owned and operated by this company is located.

Developments.—The mine is developed principally by adit drifts, stopes, winzes, and shafts, aggregating about 2,500 feet of underground work, including the tunnel or adit drift, 1,600 feet in length, on the vein. This drift has a greatest depth of 230 feet below the surface. Several shafts, mostly shallow ones, are located up to 1,050 feet from the mouth of the drift. At 800 feet from the mouth of the drift is a gasoline hoist and a 60-foot winze, reported to be sunk all the way in good ore. The property is equipped with a nearly new 40-ton mill supplied with concentrating tables.

The production is reported to be many thousand dollars in gold, silver, and lead, the zinc thus far being culled and left on the dump. The dumps also contain much second-class ore, which is said to be suitable for concentration. The mine now works about 20 men and produces about 30 tram-car loads of ore a day, of which one-fourth is shipping ore and three-fourths milling ore. The ore is shipped to the Needles smelter.

Geology and ore deposits.—The country rock is light to iron-gray fine-grained gneiss, in which the structure trends about N. 30° E. and dips steeply to the north-northwest. Toward the veins on the foot-wall side the rock is red from oxidized pyrite.

The fissure vein strikes N. 40° W. and dips about 80° NE. The croppings consist principally of leached reddish-brown quartz. The vein averages about 7 or 8 feet in width; the ore varies from about 1 foot to 3 feet in width and usually occurs on the foot-wall side of the vein. In the face of the drift at the time of visit it was 2½ feet

wide, and associated with it on the hanging-wall side was a foot or more of soft gangue composed principally of crushed and altered granitic material, which, on being removed by blasting, leaves the intact ore bared in fine condition for loading on the cars. The shoot contains parallel seams of light-colored material, which emphasizes the roughly banded character of the ore.

The ore consists in places of pure galena, but usually it contains also zinc blende, pyrite, and chalcopyrite. The gold in some of it amounts to several ounces a ton. The silver occurs in part as sulphide and native, as masses and wire silver, which locally interlaces adjacent parts of the ore shoot. The amount of zinc increases in the deeper, northern portion of the mine. Toward the northwest end of the surface workings occurs a large amount of reddish quartz ore, which seems to contain chiefly gold values. This probably represents the body of rich gold ore reported to have been found in the surface openings of the mine. A short distance north of this locality galena and zinc-blende ore with comb quartz and chalcopyrite seem to prevail.

CUPEL MINE.

The Cupel mine is situated in the foothills at Stockton Hill camp, on the south side of Cupel Wash. This mine is regarded as probably the oldest on Stockton Hill. It was located about 1863, and was worked intermittently from that date to 1891, being constantly a heavy producer. It is said to have yielded handsome returns to lessees in the seventies, and in the eighties it was opened up by an inclined shaft to the 400-foot level by Spruance, Stanley & Co., of San Francisco. From this shaft nearly half a million dollars in silver and gold ore is reported to have been taken.

The principal equipments are a steam hoist and an excellent 200-ton mill and plant of the Joplin type, recently installed. The mine is owned by the Stockton Hill Mining Company, with headquarters at Topeka, Kans. The mine is developed principally by a shaft 400 feet deep, a three-compartment shaft 150 feet deep, drifts, and stopes to a depth of about 400 feet, the workings being nearly all situated within 300 feet of the main shaft. The mine is said to produce about 25,000 gallons of water a day.

The production of the mine is conservatively reported to exceed $500,000, and is variously estimated at one to one and a half million dollars. From September 3, 1885, to May 1, 1890, according to the smelter sheets, the output was $131,405, and averaged approximately 150 ounces of silver to the ton and 20 per cent of lead, silver at that time being worth about $1 an ounce. It is stated that the mine contains much ore in sight and that the dumps contain about 2,000 tons of ore that is estimated to mill $6 or $7 net per ton.

The country rock is the pre-Cambrian gneiss and schist complex. Three veins, which strike northwesterly but are not quite parallel, contain the ore. They are known as the Cupel, Edward Everett, and Tiger veins. Several diagonal or cross veins or stringers are also present. (See fig. 17.)

The ore contains ruby silver and horn silver, together with argentite, but in places is rich in high-grade galena and carries about $5 a ton in gold. The bulk of the ore produced contains ruby silver, and some of it is said to have averaged 3,000 ounces of silver to the ton and gave to Stockton Hill and the Cerbat Mountains their early reputation. Most of the rich ore thus far produced is said to have been taken out within a horizontal distance of about 250 feet, extending principally from the shaft northwestward and from the surface to the bottom of the mine. Beyond this portion of the mine to the northwest the ore is said to contain principally galena and some gold.

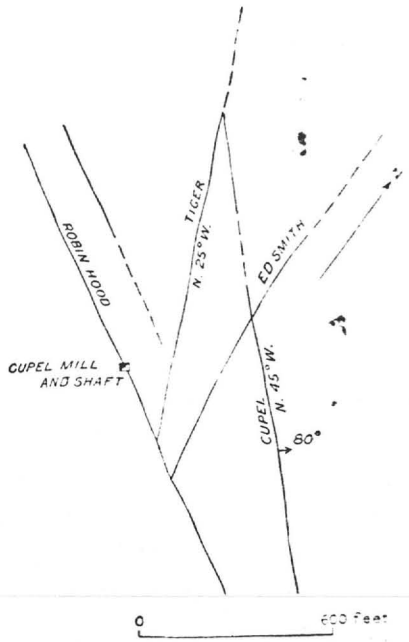


FIGURE 17.—Sketch showing relations of veins on Cupel claim.

PRINCE GEORGE MINE.

Location and history.—The Prince George Mine is located at Stockton Hill, about one-fourth mile southeast of the Cupel mine, at an elevation of about 4,600 feet. It is situated on steeply westward-sloping ground, near the head of a deep gulch that trends southward into Treasure Hill Wash.

The mine was worked principally in the eighties. After the installation of machinery the mine was operated by Mr. McKay, who soon suspended operations, since which time but little work has been done. It is now owned by the Stockton Hill Mining Company.

Production.—The production is reported to be $100,000, of which $90,000 was taken out in about ninety days, mostly from the large ore chamber.

Developments.—The principal developments are a 180-foot shaft and about 250 feet of drifts and stopes. The principal equipments are a coal or oil fuel hoist and pumps. The mine is said to produce about 20,000 gallons of water per day.

Geology.—The country rock is the pre-Cambrian complex, the prevailing phase being a medium-grained light gneiss, but next to the vein the rock is a coarse granite or pegmatite, some of which resembles graphic granite. The schistosity trends N. 30° E. and is paralleled by many small quartz stringers, none of which, however, are known to carry ore. Slickensiding in the mine indicates a nearly vertical movement.

Veins and ores.—The principal vein strikes N. 65° W. and dips about 80° NE. As shown in the mine at about 60 feet in from the mouth of the adit drift, the main vein is joined from the northwest by a second vein, which near the junction is 12 or 15 feet thick. At their junction the two veins seem to have formed an ore body 60 to 80 feet in diameter and extending to a depth of at least 50 or 60 feet below the surface. The upper portion of this ore body, particularly that in the oxidized zone, has been mined, leaving a large chamber where the ore has been removed.

The gangue is quartz and altered rock, and the ore in the unoxidized zone or lower part of the mine contains chiefly galena, argentite, and pyrite. The bulk of the ore mined from the chamber is reported to have averaged 60 per cent of lead and 300 ounces of silver to the ton, and the remainder 20 per cent of lead and 20 ounces of silver to the ton. The ore as a whole is reported to have averaged about $200 per carload, and most of the richest to have come from an ore shoot 13 feet wide.

The walls of the main vein are, as a rule, ragged, but the hanging wall of the second vein is well defined and smooth and contains a streak of ore 4 to 6 inches wide, reported to average about $600 a ton, on which the operators are now sinking. A rich 1-foot ore shoot is also reported to occur on the hanging-wall side of the main vein.

LITTLE CHIEF MINE.

The Little Chief mine is located about one-fourth mile southwest of Stockton Hill camp and about 80 feet above it, close to the main road. The mine has been worked on a small scale since the middle seventies, and has produced only high-grade shipping ore from the surface down. It is owned by the C. O. D. Mining Company. The production is reported to be more than $25,000.

The mine is developed to a depth of about 100 feet and contains about 1,000 feet of underground work, which includes a 400-foot crosscut tunnel, two 80-foot shafts, and 300 feet of drifting, the drift extending about 75 feet on either side of the two main shafts.

The country rock is the pre-Cambrian complex. To judge from talus débris on the surface at the mine, it seems to be intruded by diabase near by, and portions of a light-colored altered rock, which

seems to be the intrusive granite porphyry, are associated with the vein.

The vein trends N. 40° W. and dips steeply northeast. It is about 6 feet in width and is supposed to be the Banner vein of the Treasure Hill mine, described later. The gangue is quartz and crushed and altered silicified rock. The ore shoot locally coincides in width with the vein and is stained throughout with copper carbonate. The ore contains principally green horn silver, galena, and gold, is all of shipping grade, and is said to average about as follows: Silver, 350 ounces to the ton; gold, $5 to $10 a ton; and lead, 8 to 40 per cent.

DE LA FONTAINE MINE.

The De La Fontaine mine is situated at the west side of the district on the narrow crest of the range, at about 5,100 feet elevation, where the surface falls off steeply into Cerbat Wash on the west and Stockton Hill Wash on the east, the mouth of the adit drift or tunnel and shaft being located on the Cerbat side. The mine is owned by the Stockton Hill Mining Company. It is developed principally by a shaft 400 feet in depth and two levels comprising about 1,400 feet of drifts.

The country rock is principally a reddish fine-grained gneiss. Black amphibolite schist outcrops near by and is also present in the mine, particularly in the foot wall near the shaft on the 100-foot level. Back of the superintendent's house, a few hundred feet south of the vein, are prominent croppings of dark speckled medium-grained diorite from which the amphibolite schist has probably been derived.

The vein, which strikes N. 70° W. and dips about 80° NNE., is about 7 to 10 feet in width. The gangue is principally quartz, with some partly altered coarse granitic rock, but locally the fissure is occupied by greenish or reddish slickensiding gouge. The croppings consists of a 6-foot reef of quartz, stained by iron and manganese, and rising boldly 10 or 12 feet above the surface. The ore shoot is from 1 to about 4 feet in width. Good ore bodies of this width and of considerable extent are blocked out in the lower 300 feet of the mine.

The ore contains principally galena and zinc blende and a very little pyrite; it contains locally about $2 to the ton in gold, but the ore recently blocked out in the lower part of the mine is probably of a somewhat higher grade. The ore in sight in the mine is said to contain good values.

The company plans to treat such part of the ore as may be suitable in its mill recently installed at the Cupel mine and ship the balance to smelters.

MINES ON TREASURE HILL WASH.

The principal mines on Treasure Hill Wash are the Treasure Hill, Mocking Bird, and Sixty-three.

TREASURE HILL MINE.

Locaton and history.—The Treasure Hill mine is situated in the southeastern part of the district, in southward-sloping foothills at about 4,200 feet elevation. It was discovered late in the seventies and was worked on a small scale. From 1890 to 1900 it was owned by Lehorean Moore, who sunk five or six shafts to water level, about 65 feet below the surface, and is said to have stoped out very rich ore, some of which contained 15,000 ounces of silver to the ton. In 1902 the mine was acquired by the present owner, the Treasure Hill Mining Company, which has since sunk several shafts to the depth of about 110 feet and drifted on some of the veins, notably on veins Nos. 1 and 3. The property comprises four principal contiguous claims having a common corner and two extension claims on the southeast. The production is reported to be $100,000, of which one-half was high-grade silver ore from surface workings.

Developments.—The developments consist of a 140-foot tunnel, a 120-foot double-compartment 62° 30′ inclined shaft at the distant end of the tunnel, and a double-compartment 200-foot shaft, with drifts and crosscuts to nearly all the veins, in all aggregating about 1,000 feet of underground work. The principal equipments are a gasoline hoist, a Cornish pump with a capacity of 2,000 gallons, and engines. Heavier machinery is soon to be installed.

Geology.—The country rock is principally dark-bluish granite gneiss of pre-Cambrian age. The schistosity dips about 80° NW. The rock is intruded by a small stock of the granite porphyry. It constitutes the principal mass and upper part of the rough knob situated back of the mine and locally known as the Bronco, and it is in places associated with the veins in the mine. A schistosity is superimposed and is also older than the veins.

Veins and ores.—The veins are six in number. Beginning with No. 1, they are numbered consecutively from southwest to northeast. They average about 5 feet in width at the surface. In the southeastern part of the property they lie about parallel, strike northwest, and, except No. 4, dip for the most part steeply to the northeast. Northwest of the mine vein No. 1 curves to the left and outcrops on the southwest side of the intrusive aplitic mass, while the others lie to the east and northeast of the mass, the near ones curving out "to get past it," as the miners express it. Only the veins next to the intrusive rock are now being worked.

The gangue is principally quartz, in which the ore occurs in streaks or shoots from [illegible] to 200 feet long. The shoots usually favor the

hanging wall and are associated with clay gouge. The ore contains galena, with some pyrite and a little chalcopyrite. No zinc has yet been found on the property. The ore, so far as the experience of the present management goes, is said to average about 100 ounces of silver and $5 to $16 in gold to the ton, and from 7 to 10 per cent of lead, in both the oxidized and unoxidized zones.

According to reports of later (1908) work, 85 feet of drift run in the lower part of the mine, contains good milling values throughout its extent and width, and an unbroken small streak of high-grade ore.

SIXTY-THREE MINE.

The Sixty-three mine is located in the southern part of the district, about half a mile southwest of the Treasure Hill mine and several hundred feet above it, in the steep south side of a gulch which drains southward into Maywell Wash. The mine, which is one of the first discoveries, was found in 1863, from which date it is named. It at once became a heavy producer of very rich silver ore. After working the mine a few years, the first owners sold it to a San Francisco company, which worked it with good results and still owns it. Later it was also profitably worked by lessees. Subsequently the decline in the market value of silver and disagreement in the owning company are said to have led to discontinuance of work. The production is reported to be $500,000.

The mine is developed principally by adit drifts and tunnels to a depth of about 200 feet below the apex of the vein. The deposit is a nearly vertical fissure vein, about 3 feet in average width, in which the ore streaks average about 15 inches in width. The ore contains principally silver chloride and is mostly of high grade. Much of it is said to have averaged 3,000 ounces of silver to the ton. A considerable portion of the ore is said to have been treated in the Cerbat and Mineral Park mills and the rest was shipped to San Francisco. As there are no base metals in the ore, the mills are said to have extracted the values to a very high degree without roasting.

MINES IN I. X. L. BASIN.

I. X. L. Basin is an open basin-like area situated in the upper part of I. X. L. Wash, about 1½ miles north of Stockton Hill. It contains several small mines and prospects, about all of which are situated on the same vein or lode. The principal mines are the K. P. and the J. F. T.

K. P. MINE.

The K. P. mine is located in the southern part of the basin on open ground at about 4,700 feet elevation. The mine is [illegible]w. It

is owned by Messrs. Kimberly and Potts, of Kingman. As the water level is at about 40 feet below the surface, the developments consist principally of shallow shafts and surface openings.

The country rock is the pre-Cambrian gneiss complex. The deposit forms a vein or lode about 65 feet in width, which dips about 75° NE., and is reported to have a horizontal extent of nearly 2 miles, many locations being made on it. The gangue or filling of the fissure consists essentially of crushed or brecciated vein quartz and crushed and altered coarse granitic quartz and feldspar. The croppings consist of similar material, locally silicified and stained reddish brown and black by iron and manganese oxides. The lode carries a width of about 7 feet of concentrating ore.

The ore is of low grade. It contains principally galena and is said to average about 60 per cent of lead. It contains also some gold, silver, and copper, the copper occurring as bornite and chalcopyrite.

J. F. T. MINE.

The J. F. T. mine, located in the upper or northwestern part of the basin, is said to be developed to a depth of about 200 feet. It is reported to have been a good producer, and its ore is said to contain copper, silver, and gold.

MINES IN C. O. D. WASH.

C. O. D. Wash is located about a mile north of I. X. L. Basin. Its principal mine is the C. O. D. mine.

C. O. D. MINE.

Location and history.—The C. O. D. mine is about 2½ miles north of Stockton Hill, in the upper or gulch part of C. O. D. Wash, at about 4,900 feet elevation. It is easily reached by a good wagon road. The mine was located about 1878 and was worked in a desultory manner until 1885, when active work was begun on the property. About 4,000 tons of ore was produced in the next seven years. Activities were renewed about 1900, with an output of several hundred tons of concentrates. In 1902 machinery and a mill were installed, immediately after which the mine and mill were operated for a period of six months, when, owing to decline in the market value of silver and, it is said, mismanagement and lack of proper machinery, the plant was closed. Later the Fletcher Mining Company leased the mine under bond and worked it for a short time, shipping the ore to Needles, but is said to have soon stopped operations for want of funds. The mine was closed again November 19, 1904, and operations have not yet been resumed.

The property is reported to comprise eight claims. It is now owned by the Taggart Mercantile and Mining Company, of Kingman. The mine is filled with water up to the first level.

Developments.—The mine is developed principally by a main shaft (No. 1) about 400 feet deep and by drifts and stopes on and between two main and two subordinate levels, aggregating about 2,500 feet of underground work.

From the second or 300-foot level to the surface the ore, except some of low grade, has been mostly stoped out for a distance of about 400 feet on either side of the shaft, especially on the east side, beyond which good ore is reported. The second level extends to a point 900 feet west of the main shaft, where connection with the surface is contemplated by a new double-compartment shaft (No. 2), which is now 96 feet in depth and on completion is to be used as a main working shaft of the mine. At about 1,200 feet west of this shaft a third shaft (No. 3) is sunk to the depth of 60 feet.

The principal surface equipments are a 50-ton concentrating mill containing rolls and three Bartlett concentrating tables, a 50-horsepower engine and boiler, and two rock crushers; a steam hoist with a 40-horsepower engine; a gasoline fan with a 10-horsepower engine, and a pump. The principal source of the power used is fuel oil. The mine is reported to yield sufficient water for operating the plant.

Geology.—The country rock is mainly dark-gray coarsely porphyritic gneissoid microcline granite. It is the dominant rock from Stockton Hill to a point beyond C. O. D. Gulch. Locally it is associated with dark fine-grained chlorite schist, in which the 60-foot shaft on the west is located. The rocks are cut by dikes of a greenstone or altered basalt. Schistosity and jointing strike N. 20° W., with vertical dip. A secondary system of joints trend N. 70° W. and dips about 80° S. and seems to be parallel with the C. O. D. vein, whose fissure probably belongs to the system.

Veins and ores.—The vein is well known as the "C. O. D." vein: it strikes N. 85° W. and dips about 80° N., and is reported to be more than a mile in length and about 6 feet in average width. The gangue is mainly quartz, in which the ore occurs in shoots and lenses which vary from 1 to 7 feet in width and are mostly of considerable extent. The narrow shoots are said to be usually rich, and the wider ones contain large bodies of milling and concentrating ore. At the 250-foot level the ore shoot is reported to vary from 3 to 7 feet in width and its ore to have averaged about $250 to the ton.

The ore contains principally silver sulphide and gold, with some galena, zinc blende, and below the 250-foot level a little chalcopy-

rite.[a] It is said to be less rich in the sulphide zone in the lower part of the mine than in the oxide zone near the surface. Its run of mine, roughly computed from a record of the output from October 10, 1885, to March 6, 1901, is about as follows: Silver 160 ounces and gold 2 ounces to the ton; lead, 12 to 20 per cent.

Production.—The production is reported to be $1,300,000, that of silver alone amounting to about $1,000,000; and several thousand dollars' worth of medium-grade ore are said to now lie on the dump. The output was mostly made between the autumns of 1885 and 1892. During this period 3,687 tons of ore are reported, according to smelter return sheets, to have contained about 402,000 ounces of silver, 1,180 ounces of gold, and 515,760 pounds of lead. Later, about 1900 to 1902, about 17,550 ounces of silver, 180 ounces of gold, and 114,360 pounds of lead are said to have been obtained from 330 tons of concentrates.

MINES OF CANYON STATION WASH.

In Canyon Station Wash, about a mile north of C. O. D. Wash, there are reported to be several small mines, of which the most important seem to be the Baden-Baden, King, and Queen mines, said to be owned by Lewis Davidson, of Kingman.

MINES IN "TOP OF STOCKTON HILL" AREA.

The "top of Stockton Hill" is situated in the northwestern part of the district, at the crest of the range, between the northern part of the Cerbat district on the west and the heads of I. X. L. and C. O. D. washes on the east. The mines include the Cincinnati, Miner's Hope, Blue Bell, Fountain Head, Brown, and others, the most important of which seems to be the Cincinnati. It is situated near the crest of the range about midway between Lane Springs and I. X. L. basins. It has not been worked for many years, but is regarded as a good property.

GOLD BASIN DISTRICT.

GENERAL FEATURES.

The Gold Basin mining district, of which Basin is the post-office, is situated in the eastern part of the White Hills (fig. 18). It extends over a hilly area about 6 miles in diameter, sloping to Hualpai Wash on the east, and ranges from 2,900 to 5,000 feet in elevation. The northeastern portion, where most of the mines are situated, is rugged, being marked by longitudinal fault scarps and scored by

[a] The mine is said to contain no copper above the 200-foot level, but in an opening about half a mile west of the mine and about 500 feet above it, on what is thought to be the same C. O. D. vein, the ore, which here occurs in a milk-white quartz gangue, contains chiefly bornite and chalcopyrite, with some zinc blende, and about $20 in gold to the ton.

several deep transverse washes, of which the principal ones are Banker, O. K., and Cyclopic, situated about 2 miles apart. The nearest railway station is Hackberry, 40 miles to the south, with which connection is made by stage line. Colorado River lies 16 miles to the north. Mineral was first discovered here early in the seventies, but remoteness from the base of supplies, together with scarcity of fuel and water, renders operations expensive and has materially retarded developments. Nevertheless, considerable progress has been made and much ore has been produced and worked in arrastres and mills.

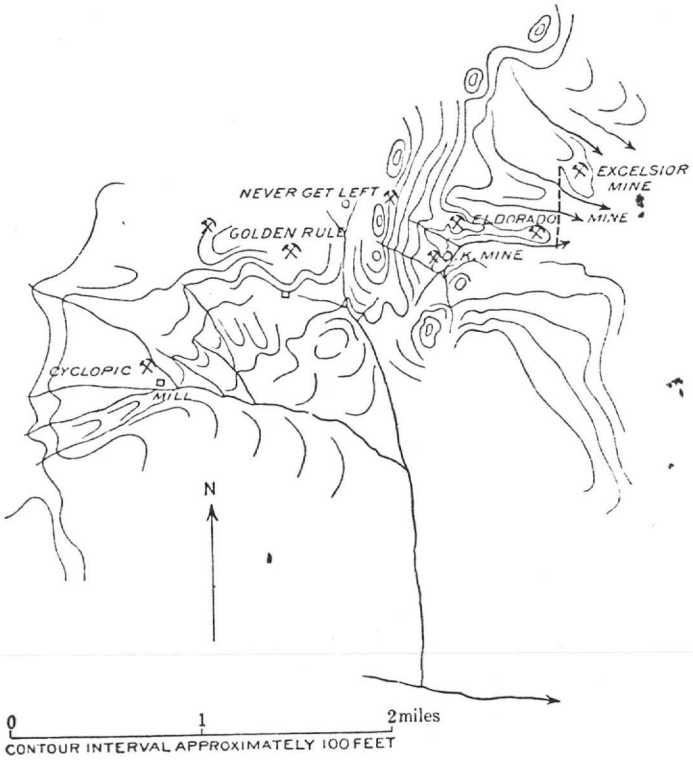


FIGURE 18.—Sketch map of Gold Basin district.

The deposits occur mainly in fissure veins in the pre-Cambrian crystalline rocks. The veins dip southeastward or northwestward, mainly at angles of 40° or 70°. The gangue is quartz, in places with siderite, and the metal is gold, mostly free milling, but it is associated with lead or copper ores, copper stain being a good indication of the gold values. Pyrite, chalcopyrite, galena, molybdenite, and wolframite are found, but the ore is largely oxidized, the water level not having been reached. Among the oxidized products are limonite, malachite, cerusite, and vanadinite.

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