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# RIGIN OF CERTAIN RICH SILVER ORES NEAR CHLORIDE AND KINGMAN, ARIZONA

BY

EDSON S. BASTIN

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ILLUSTRATIONS.



NOTE.—Owing to the fact that only a few papers were available for th "Contributions to economic geology" for 1923 they will be combined wit those for 1924 in a single volume, and no separate volume for 1923 will b published.





# ORIGIN OF CERTAIN RICH SILVER ORES NEAR CHLORIDE AND KINGMAN, ARIZONA.

By EDSON S. BASTIN.

## INTRODUCTION.

The mineral deposits of the Cerbat Mountains between Kingman and Chloride, in northwestern Arizona, were described by Schrader [1] in 1909. The writer visited some of the silver mines and prospects of the Cerbat Mountains in 1913, in the course of a study of silver enrichment undertaken by the United States Geological Survey in many mining camps of the western United States. The work of preparing the results for publication has been delayed by the war and other causes.

The practical application of the results lies in the determination of the extent to which the several silver minerals of the ore are secondary or primary and hence to what extent they are likely to play out at moderate depths or to persist below the reach of surface processes of alteration. The results are summarized at the end of the report.

The mines described were reached from Kingman, on the main line of the Atchison, Topeka & Santa Fe Railway, and from Chloride, the terminus of a short railroad line from Kingman.

## GENERAL FEATURES OF THE AREA.

The area here considered is arid, with hot summers and mild winters. The annual precipitation is about 5 inches, almost never in the form of snow. The area is for the most part treeless, and its vegetation is of desert types.

The Cerbat Mountains constitute one of the numerous desert ranges of nearly north-south trend that form a characteristic feature of the Great Basin topography. In the parts of the range under discussion the altitude ranges between 4,000 and 6,000 feet.

The Cerbat Mountains consist in the main of pre-Cambrian igneous and metamorphic rocks, and these form the wall rocks at all the mines

[1] Schrader, F. C., Mineral deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: U. S. Geol. Survey Bull. 397, 1909.

visited. Near Kingman and along the western flank of the range occur rhyolite, andesite, and other volcanic rocks of Tertiary age. The familiar desert wash occupies the valleys that flank the mountains.

The ore deposits of the Cerbat Mountains are veins of prevailingly northerly or northwesterly strike and steep dip. All those studied have been worked mainly for their silver content, although minor amounts of gold were present in some. A few veins worked mainly for their base metals were not included in this investigation. The veins are believed by Schrader to have been formed in Tertiary time and to be connected in origin with the granite porphyry of the area.

The bulk of the silver produced in this area in the seventies and eighties came from oxidized ores extending from the surface to depths varying from 50 to 300 feet. Cerargyrite (horn silver) and native silver were the dominant silver minerals of these ores. In the lower part of the oxidized zone ruby silver (proustite) was commonly present, in places so abundantly as to constitute very rich ore. Most of the silver veins were worked to depths of only a few hundred feet and in 1913 had been idle for many years. Few workings could be entered, and samples of the ores were obtained mainly from the dumps or were generously donated by former operators from their personal collections. Specimens of the rich oxidized ores were not available, and these studies therefore relate almost wholly to the sulphide ores.

The reasons for the suspension of mining on most of the silver veins were probably complex. Foremost, perhaps, was the rapid decline in the price of silver between 1885 and 1895. To this was added the fact that the sulphide ores were in general not as rich as the oxidized ores and were more costly to mine. Resumption of mining during the recent period of high silver prices has perhaps been hindered by a fear that the best of the ruby silver ores also owed their richness to enrichment by waters of surface origin, but as indicated on pages 36–39 this belief appears to have no justification in fact.

## CHLORINE IN SURFACE WATERS.

The abundant development of silver chloride in the oxidation of the ores of this desert area suggested the testing of the surface waters for chlorine by neutralization with silver nitrate tablets of known weight in the presence of an indicator. Because most of the streams are intermittent only one good opportunity presented itself for such a test. The water of a stream in Tennessee Wash, a quarter of a mile east of the Elkhorn shaft, was collected at a point where it emerged from a dry wash. This water carried about 80 parts per million of chlorine, a large content as contrasted, for example, with the average chlorine content of surface waters close to the New England coast, which is about 6 parts per million.[2] For comparison may be cited the chlorine content of 65 parts per million[3] in descending mine waters in the West End mine (500-foot level) at Tonopah, Nev., and of 127 parts per million[4] in similar waters of the Comstock lode, Nev. Both these Nevada waters occur in regions climatically much like the Chloride-Kingman area.



## DETAILED DESCRIPTIONS.

### DISTAFF MINE.

The Distaff mine is about three-quarters of a mile east of Chloride. The shaft is on the southwest slope of a small hill, and the shaft collar is about 250 feet above the level of the plain on which the town is situated.

The wall rock is somewhat gneissic granite, and the vein, 2 to 3 feet in width, is nearly vertical and strikes nearly north, about parallel to the foliation in the granite. The vein has been traced for about a mile. The principal surface indications of the presence of a vein are several bands of white quartz 1 to 3 inches in width. When this quartz from the surface is broken it is occasionally found to inclose pyrite, but commonly small limonite-stained cavities mark the original position of the pyrite grains; in addition there is staining with limonite along fractures traversing the vein and the granite. There is no heavily iron-stained gossan or "iron hat."

The Distaff shaft was reported to be 265 feet deep, with short levels at 100, 200, and 250 feet. At the time of visit the mine was idle and the water stood about 220 feet below the collar of the shaft—that is, close to the level of the flats bordering the hill on which the mine is situated.

All ore above the 250-foot level is reported to have shown oxidation. Horn silver (cerargyrite) was the principal silver mineral from the surface to depths of 100 to 150 feet. Native silver was most abundant somewhat deeper; some occurred on the 100-foot level, but most of it between the 200 and 250 foot levels. Schrader[5] mentions the occurrence of slabs of native silver many pounds in weight. A specimen in the collection of Jack Lane at Kingman showed a slablike mass of native silver one-eighth of an inch thick along a fracture in sulphide ore. Wire silver occurred in small vugs in this ore.

[2] Jackson, D. D., The normal distribution of chlorine in the natural waters of New York and New England: U. S. Geol. Survey Water-Supply Paper 144, 1905.

[3] Bastin, E. S., and Laney, F. B., Genesis of the ores at Tonopah, Nev.: U. S. Geol. Survey Prof. Paper 104, p. 29, 1918.

[4] Bastin, E. S., Bonanza ores of the Comstock lode, Virginia City, Nev.: U. S. Geol. Survey Bull. 735, p. 60, 1922.

[5] Op. cit., p. 60.

In ore from the bins argentite was noted in two associations—(1) in scattered thin fungus-like patches along fractures in unoxidized ore, and (2) intimately associated with proustite and pearceite in quartz-lined vugs in unoxidized ore; some of this argentite is well crystallized. In one specimen from the 250-foot level small octahedral crystals of argentite show quartz crystals coating them or implanted on them. Minute amounts of chalcopyrite and sphalerite are intercrystallized in places with this argentite, and all three minerals should apparently be interpreted as primary (hypogene), whereas the argentite occurring in fungus-like patches along fractures is probably secondary (supergene).

Proustite was noted in ore from the 250-foot level in irregular masses as large as the end of a man's thumb, in places well crystallized. It is intimately intercrystallized with quartz, sphalerite, and pyrite and has every appearance of being contemporary with them and primary.

A small specimen from the ore bins shows a very fine intergrowth of proustite, pearceite, and chalcopyrite bordering an association of base-metal sulphides, mainly sphalerite and pyrite. The silver minerals and chalcopyrite were clearly the latest to crystallize; they interlock, however, with the base-metal sulphides and are believed to be late primary (hypogene). The primary origin of the proustite is confirmed by the microscopic study of a specimen from the ore bins. The main portion of a 3-inch veinlet shown by this specimen is a granular aggregate of galena, sphalerite, and pyrite, but next one wall is a quarter to half an inch of gray quartz carrying scattered grains or crystals of chalcopyrite, proustite, and pearceite. In the polished specimen some areas of galena lie within 1 millimeter of areas of pure proustite, but tarnishing of the galena with hydrogen peroxide shows that it has not been replaced even incipiently by proustite or other minerals. In places proustite is intercrystallized with chalcopyrite very intimately. The contacts between these two minerals are crystal faces and not the ragged contacts usually developed by the replacement of one metallic mineral by another. Furthermore, the chalcopyrite areas in one place show a radiating arrangement. Neither mineral forms veinlets in the other. The two minerals are interpreted as contemporary and primary (hypogene).

To summarize the evidence obtained at this mine bearing on the origin of the rich silver ores: The zone of oxidation is 200 to 250 feet deep. Within this zone oxidation of sulphides has been only partial, and no heavily iron-stained gossan has been developed. From the surface to depths of 100 to 150 feet the dominant silver mineral appears to have been horn silver (cerargyrite). This mineral, here as everywhere else, is a product of weathering. Lower down, from depths of 100 to 250 feet, native silver was abundant. It occurred as plates in fractures and as wires and teeth in vugs. Its disappearance in depth shows that it also was a product of near-surface oxidation. Some argentite occurring along fractures is also probably a result of alteration near the surface.



Primary (hypogene) minerals noted are quartz, pyrite, sphalerite, galena, chalcopyrite, proustite, pearceite, and probably argentite. Evidence of the primary origin of the silver minerals is found in the entire absence of replacement phenomena in ores in which these minerals are abundant. The silver minerals can not reasonably be regarded as having completely replaced older minerals, inasmuch as galena adjacent to them is wholly unreplaced. Galena is one of the minerals most readily replaced by silver minerals in the process of downward enrichment. Primary origin is also indicated by the intimate contemporaneous intergrowth of proustite with chalcopyrite, a mineral formed only rarely in processes of downward enrichment.

### EMPIRE MINE.

The Empire mine, about 2 miles north-northeast of Chloride, was not visited by the writer, but a specimen of rich silver ore from a depth of 150 feet on the vein was presented by the owner, Mr. E. F. Thompson, and was studied in detail.

The specimen is unoxidized and carries pyrite, arsenopyrite, quartz, sphalerite, galena, tennantite, and proustite. It shows the entire width of a 1½-inch vein. In the median portion of this vein tennantite, proustite, and quartz are the dominant minerals, but there is complete gradation from the silver-rich central portions to the border portions carrying mainly the base-metal sulphides.

Microscopic study shows that the proustite and tennantite are commonly intergrown and that the proustite-tennantite contact shows the crystal outlines characteristic of tennantite, as is shown in Figure 2. The proustite can not therefore have replaced tennantite, nor is there any evidence of replacement of any sort in the polished specimens. The galena when tarnished with hydrogen peroxide shows absolutely no replacement by other minerals. Evidence of the primary (hypogene) character of the proustite in this specimen appears to be conclusive.

### GEORGE WASHINGTON CLAIMS.

The George Washington group of claims, in Mineral Park, about 3 miles southeast of Chloride, was in 1913 being developed through a tunnel then 300 feet long. The vein exposed in this tunnel was nearly vertical and had a strike of N. 40° W. Widths up to 3½ feet were noted. The dominant vein minerals are quartz and pyrite, but silver minerals are present in fair abundance in about 1 foot of the vein thickness next the southwest wall. The vein walls, which are granite, show alteration of the feldspars and carry disseminated small crystals of pyrite.

The workings are all shallow, even the face of the tunnel attaining a vertical depth of only about 80 feet below the surface. Even at these slight depths, however, much of the ore, because of its dense, fine-grained texture, is unoxidized. Oxidation is limited to the immediate vicinity of fractures traversing the ore and commonly does not extend more than 1 or 2 centimeters from such fractures.

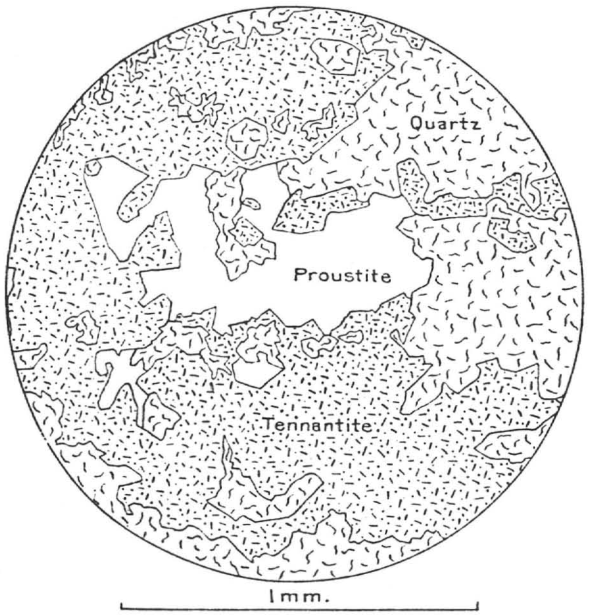


FIGURE 2.—Primary (hypogene) intergrowth of proustite with tennantite and quartz, Empire No. 2 mine, Chloride, Ariz.

Ore obtained near the face of the main tunnel is reported by the operators to have assayed $175 to the ton, mainly in silver. Assays of $240 a ton were reported from lesser depths on the vein.

Three specimens of the richest ore were collected for detailed study; one came from a depth of 56 feet and the others from depths of about 80 feet. In most respects these samples are similar. All are fine-grained grayish aggregates of quartz carrying scattered sulphides in grains that rarely exceed 1 millimeter in diameter. Oxidation is confined to fractures and to the 1 or 2 centimeters of ore adjacent to them. Vugs are rare in the unoxidized ore, but a few as much as 5 millimeters across were noted.

The primary ore minerals identified, in the approximate order of abundance, are quartz, pyrite, proustite, chalcopyrite, arsenopyrite,



polybasite, and sphalerite. The secondary minerals noted are native silver and covellite.

Evidence of the primary (hypogene) origin of the silver minerals, proustite and polybasite, though negative is convincing. It consists in the absence of any suggestion that these silver minerals have replaced older minerals. The relatively large unmixed areas of proustite or polybastite must either be primary or the results of complete replacement of older minerals. In places, however, they occur adjacent to chalcopyrite that has been peripherally replaced by covellite. Complete replacement of some older mineral by proustite and

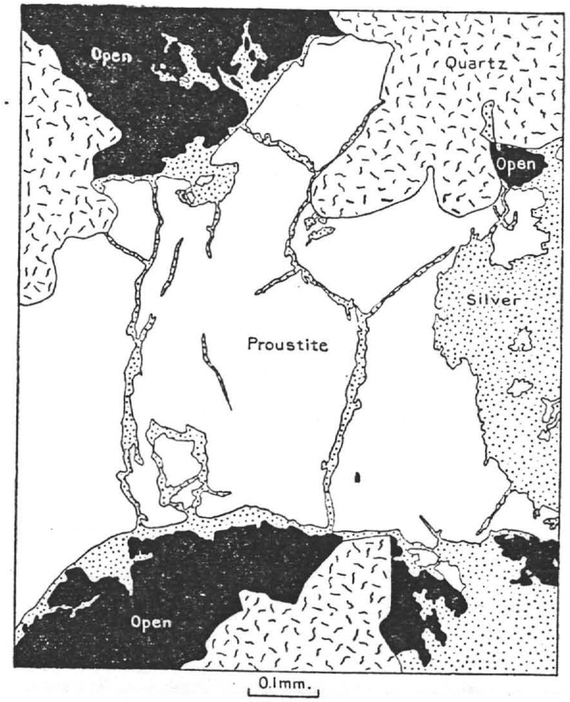


FIGURE 3.—Replacement of proustite by native silver, George Washington claim, Mineral Park, Ariz.

polybasite is hardly compatible with the incipient replacement of chalcopyrite by covellite close by; it is much more probable that the sulphosalts of silver are a primary deposit from the same solutions that deposited pyrite, chalcopyrite, quartz, and the other undoubtedly primary minerals.

Added indication that the proustite and polybasite are primary is found in their replacement near small open spaces in the ore by native silver, after the fashion shown in Figure 3. These replacement deposits are confined to porous and somewhat oxidized portions of the ore and are clearly the result of alteration by waters of surface origin. In degree the replacement of proustite by silver is compatible with that of chalcopyrite by covellite in the same specimen, and both are attributed to descending oxidizing solutions.

The silver content in the specimens examined is therefore in part primary, in proustite and polybasite, and in part secondary, as native silver. The primary silver content is high—sufficient in itself to produce a rich silver ore. Such abundance of primary sulphosalts of silver in ores from depths of only 50 to 80 feet is unusual but is due to the dense, highly quartzose, fine-grained nature of the ore, which narrowly limits oxidation and enrichment to the immediate vicinity of fractures.

### RURAL AND BUCKEYE MINES.

The Rural and Buckeye mines are about 1½ miles northeast of Mineral Park and are a few hundred feet apart on the same vein. The wall rocks are granite gneiss and schist of pre-Cambrian age, intruded by dikes of much younger granite porphyry. The vein is nearly vertical and from 2 to 8 feet wide. All workings were inaccessible in 1913, the mines having been idle for many years. Ground water stood at a depth of about 50 feet below the collar in the Rural shaft.

Ores seen on the dumps showed pyrite, arsenopyrite, and quartz as the dominant minerals, with chalcopyrite, sphalerite, and galena subordinate. No silver minerals were seen on the dump, but native silver is abundant in specimens from this mine seen at Kingman. One specimen in the collection of E. F. Thompson shows a mass of nearly solid native silver 1½ inches across.

The following records show the tenor of the richer ores:

*Tenor of smelting ores shipped from Rural and Buckeye mines in 1886–87.*

| Net weight (pounds). | Silver (ounces per ton). | Gold (ounces per ton). | Net weight (pounds). | Silver (ounces per ton). | Gold (ounces per ton). |
|---|---|---|---|---|---|
| 9,033 | 722 | 6.13 | 29,862 | 266 | 5.85 |
| 8,024 | 440 | 2.66 | 21,106 | 219 | 4.00 |
| 13,089 | 200 | 2.55 | 72,680 | 480 | 8.25 |
| 28,376 | 479 | 9.46 | 10,212 | 442 | 8.16 |
| 23,575 | 119 | 4.90 | 27,142 | 172 | 4.70 |
| 30,999 | 196 | 6.05 | 87 | 4,467 | 4.80 |
| 9,898 | 109 | 5.12 | 167 | 4,024 | 5.35 |
| 20,314 | 73 | 7.29 | | | |

### QUEEN BEE MINE.

The Queen Bee mine is in the northwestern part of the Mineral Park district, close to the cut-off trail to Chloride. The mine is owned by James B. Uncopher, of Mineral Park, to whom the writer is indebted for valuable information and specimens. The property when visited in 1913 had been idle for many years, and none of the workings could be entered. The main shaft, 225 feet deep, was filled with water within 60 feet of the surface.



The wall rock at the mine is mica schist of pre-Cambrian age. The ore is said to be somewhat oxidized to a depth of about 70 feet. The following minerals were noted in specimens from the mine dump and from Mr. Uncopher's collections:

Primary (hypogene): Quartz, pyrite, arsenopyrite, manganiferous siderite, calcite (white), sphalerite, galena, tennantite, chalcopyrite, proustite, pearceite (probably primary), argentite (probably in part primary).

Secondary (supergene): Argentite, native silver, cerargyrite (reported by Schrader[6]).

The proustite abundant in many of the ores from this mine appears clearly to be a primary (hypogene) mineral deposited from the same mineralizing solutions that deposited the common base-metal sulphides; the evidence for this conclusion is given below.

In one specimen studied a piece of proustite three-fourths by three-eighths by one-half inch in dimensions was intercrystallized with quartz and ferruginous calcite, all three minerals interlocking and having apparently been deposited contemporaneously. In one specimen in Mr. Uncopher's collection proustite in vugs is wholly inclosed by calcite. Other well-formed crystals of proustite are coated with calcite.

A particularly rich specimen of unoxidized ore donated by Mr. Uncopher shows the entire width of a 2½-inch veinlet carrying abundant proustite. Microscopic examination shows that in general the proustite has not replaced other ore minerals. The galena when tarnished brown with hydrogen peroxide (which does not tarnish the silver minerals) usually shows no evidences of replacement. Figure 4 shows a contact between galena and an intergrowth of proustite and sphalerite. The galena can not have been replaced by proustite alone, because there are no sphalerite areas in the galena corresponding to those so abundant in the proustite. Simultaneous replacement of galena by an intergrowth of proustite and sphalerite is highly improbable and if it occurred would probably be a part of the process of primary (hypogene) mineralization, for the deposition of sphalerite in the downward enrichment of ore deposits is extremely rare. The proustite is interpreted as hypogene and broadly contemporaneous with galena and sphalerite.

Additional evidence that most of the proustite is not the result of a replacement of galena is found in the fact that in many places minute inclusions of chalcopyrite are abundant in the proustite but are absent from the adjacent galena.

[6] Op. cit., p. 86.

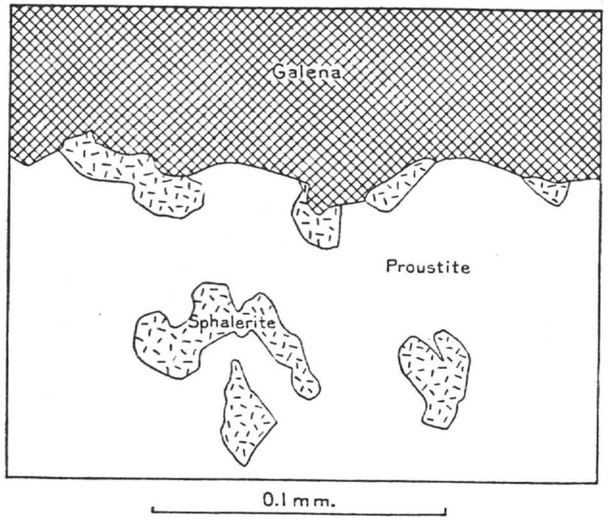


FIGURE 4.—Contact relations of proustite and sphalerite with galena, Queen Bee mine, Mineral Park, Ariz.

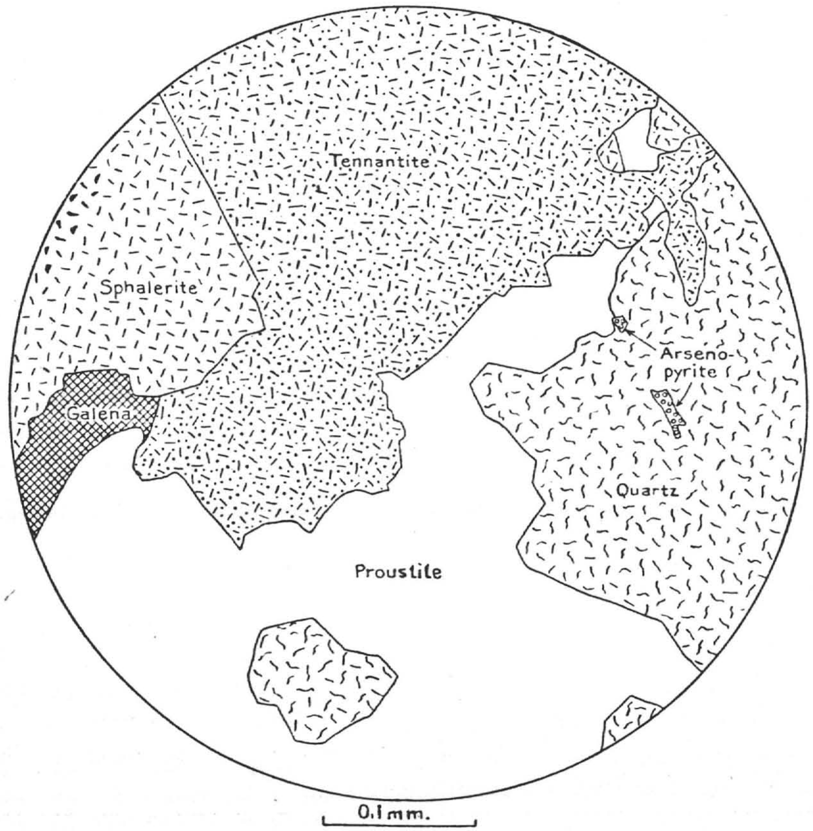


FIGURE 5.—Primary (hypogene) association of proustite and tennantite, Queen Bee mine, Mineral Park, Ariz.



Throughout the mine the proustite is intimately intergrown with tennantite and for this reason appears to the unaided eye somewhat darker than most proustite. It is clear that the two sulpharsenides—of silver and of copper, respectively—crystallized at essentially the same time. When their intergrowths are examined in detail it is found that the tennantite shows its own characteristic crystal faces against proustite, as illustrated in Figure 5. If the proustite had replaced tennantite, crystal faces of the tennantite should have been destroyed. The proustite is therefore interpreted as a primary (hypogene) deposit.

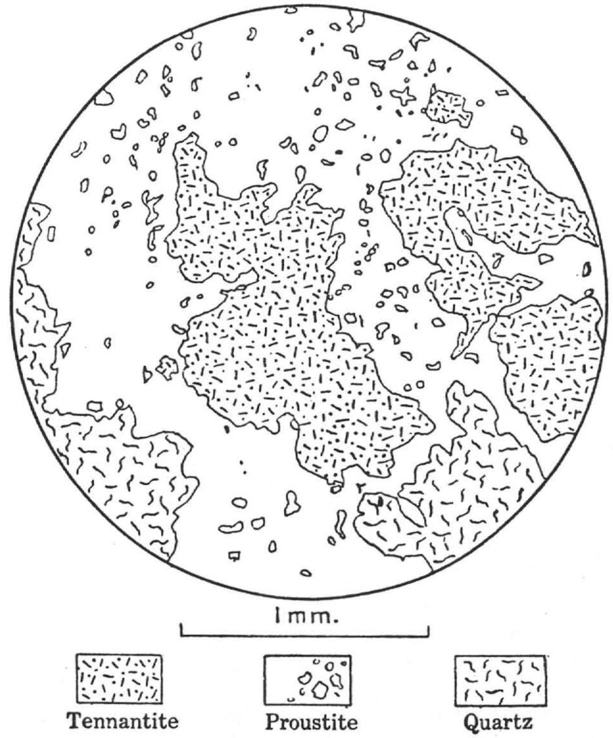


FIGURE 6.—Proustite crowded with inclusions of sphalerite and chalcopyrite and bordering tennantite essentially free from such inclusions, Queen Bee mine, Mineral Park, Ariz.

Additional evidence that proustite has not replaced tennantite is furnished by the fact that many areas of tennantite carry few and small inclusions of sphalerite, whereas immediately adjacent areas of proustite carry numerous and relatively large sphalerite inclusions, as is shown in Figure 6.

The presence of inclusions of sphalerite and chalcopyrite in both proustite and tennantite is itself an indication of the primary (hypogene) origin of the proustite, as chalcopyrite, sphalerite, and tennantite are rarely products of enrichment.

In a few places inclusions of proustite occur in galena in the manner illustrated in Figure 7. The inclusions have straight crystal outlines, but these bear no definite relation to the crystallographic directions of the inclosing galena. Replacement of galena by a silver mineral is usually controlled by the galena cleavages or by its contact planes with other minerals; absence of such control indicates that replacement has probably not been operative. The proustite inclusions are interpreted as primary (hypogene).

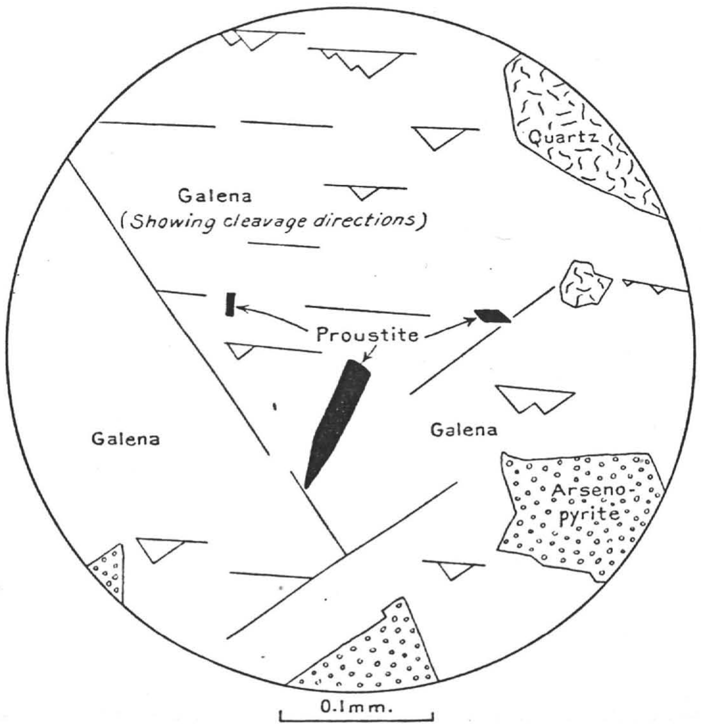


FIGURE 7.—Inclusions of primary proustite in galena, Queen Bee mine, Mineral Park, Ariz.

A possible partial exception to the rule that the proustite has not replaced other minerals is illustrated in Figure 8. The minute veinlets of proustite shown in this figure parallel cleavage directions in the galena and are interpreted as formed mainly by fracture filling, combined possibly with slight replacement. These veinlets of proustite are rare and are interpreted as of late primary (hypogene) origin rather than products of downward (supergene) enrichment.

Argentite occurs here and there. A specimen in Mr. Uncopher's collection shows calcite, argentite, and wires of silver in vugs. One



octahedron of argentite is a quarter of an inch in diameter, and in places argentite is so intimately intercrystallized with calcite as to leave little doubt that it is primary (hypogene). In other specimens argentite forms patches or fungus-like growths along fractures cutting primary sulphides. Such argentite is very probably secondary (supergene).

Pearceite is also of local occurrence. One specimen shows tabular hexagonal crystals of pearceite in vugs. On some of these small

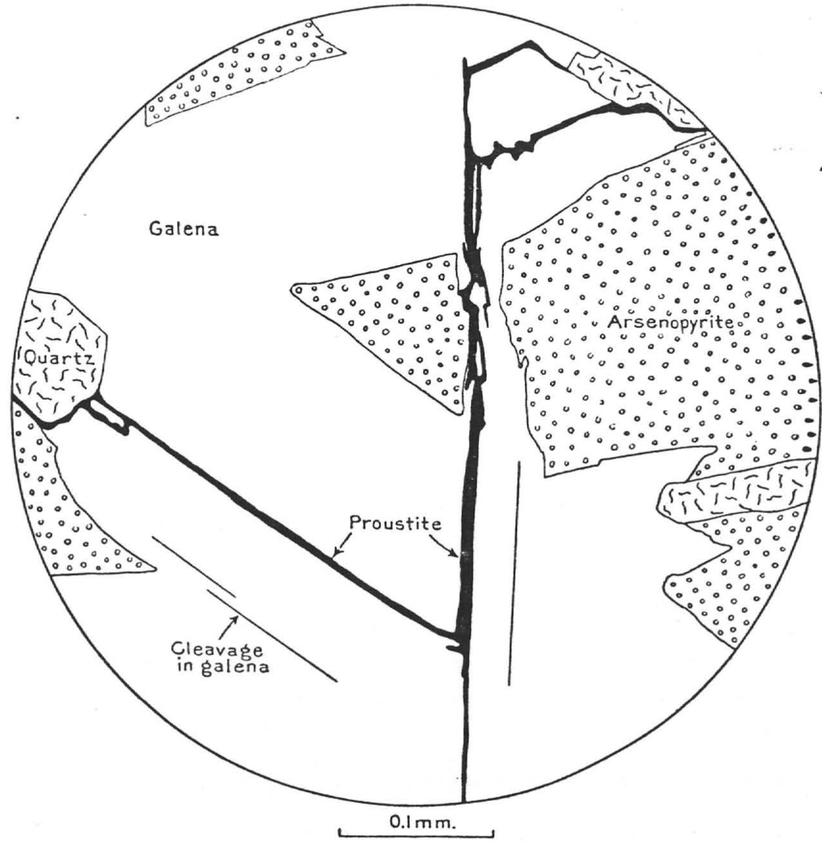


FIGURE 8.—Veinlets of proustite following cleavage planes in galena and contacts between galena and quartz, Queen Bee mine, Mineral Park, Ariz.

crystals of chalcopyrite have later been deposited. As chalcopyrite is rarely a product of downward enrichment, this pearceite is probably though not demonstrably primary.

Native silver is clearly secondary (supergene). It occurs as wires and teeth attached to argentite, proustite, and pearceite in vugs and is manifestly formed by their alteration. Native silver also occurs in matted masses of wires and teeth along fractures in sulphide ore.

Here it is associated with remnants of argentite, from which it was probably derived. In a number of places the silver is in contact with unetched crystals of calcite or of manganiferous siderite, an association which indicates that it was not deposited from solutions that were notably acid.

### KAY CLAIM.

The Kay claim is about half a mile northwest of the settlement of Mineral Park. A steeply dipping vein striking nearly due east is developed by a shallow shaft and a short tunnel, neither of which was accessible in 1913. The shaft is near the bottom of a small gulch, and ground water stood only 25 feet below its collar. The vein traverses medium-grained granite. Proustite is reported to have occurred within a few feet of the surface in this vein. Specimens of ores were collected from the dump, and two were obtained from Mrs. Kay.

The minerals recognized in the ore, in the approximate order of abundance, are as follows:

Primary (hypogene): Quartz, pyrite, sphalerite, tennantite, pearceite, proustite, galena, chalcopyrite.
Secondary (supergene): Chalcocite, native silver, copper pitch ore, malachite.

Of the primary minerals quartz, pyrite, sphalerite, and galena were the oldest; after their deposition some brecciation occurred, and additional quartz and chalcopyrite, tennantite, pearceite, and proustite were deposited in the fractures so produced. The pearceite and proustite are most abundant and occur in the largest masses near small vugs. The later quartz is white; the earlier is dark gray.

In the granite of the wall disseminated grains of pyrite are abundant.

Evidence that the silver minerals pearceite and proustite are primary is found (1) in the absence of any indication that they have replaced earlier minerals and (2) in the intimate penetration of tennantite by crystals of these silver minerals, as sketched in Figure 9. In this figure proustite and pearceite are not differentiated by separate symbols, but both show similar relations, with characteristically sharp crystal outlines against tennantite. The narrow lathlike white areas in the tennantite of this figure are mostly pearceite; the larger white areas are mostly proustite. There is no evidence that the proustite of this specimen replaces either tennantite or pearceite.

In some vugs in the same specimen from which Figure 9 was sketched wires and teeth of native silver have been developed by the alteration of proustite and pearceite.



### KING CLAIM.

The King claim, at Mineral Park, was located to develop a vein striking nearly east and dipping steeply south. Prior to 1913 two shafts, 35 and 50 feet deep, had been sunk on the vein, and two short tunnels had been run.

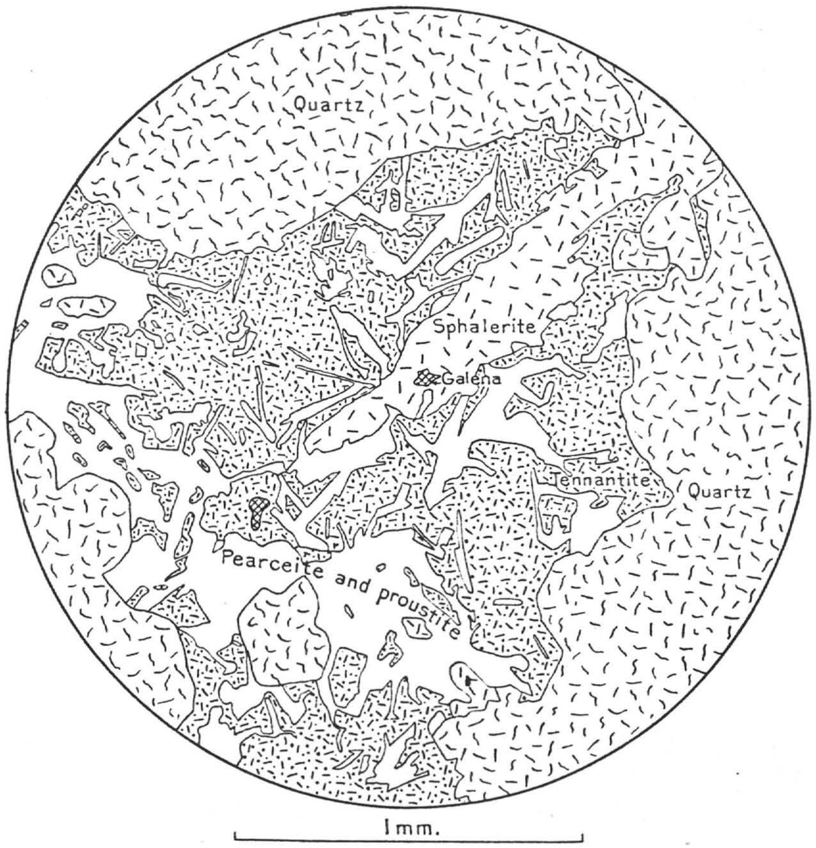


FIGURE 9.—Primary intergrowth of proustite and pearceite with tennantite, Kay mine, Mineral Park, Ariz.

The vein as exposed in the tunnels is 6 inches to 2 feet wide and shows gray quartz carrying scattered pyrite. Ore seen on the dump carried the following minerals:

Primary (hypogene): Quartz, pyrite, sphalerite, galena, chalcopyrite.
Secondary (supergene): Covellite, chalcocite, native copper.

A specimen from the mine dump when polished showed peripheral replacement of chalcopyrite and sphalerite by covellite. Ore from a depth of 12 feet shows dendritic growths of native copper along small fractures in flinty-looking quartz. Another specimen obtained within a few feet of the surface at this mine shows chalcocite developed along and close to small fractures in granite. The chalcocite appears to replace pyrite, remnants of which remain within some of the chalcocite. In places native copper in thin platelike masses is associated with the chalcocite and appears to be an alteration product from it.

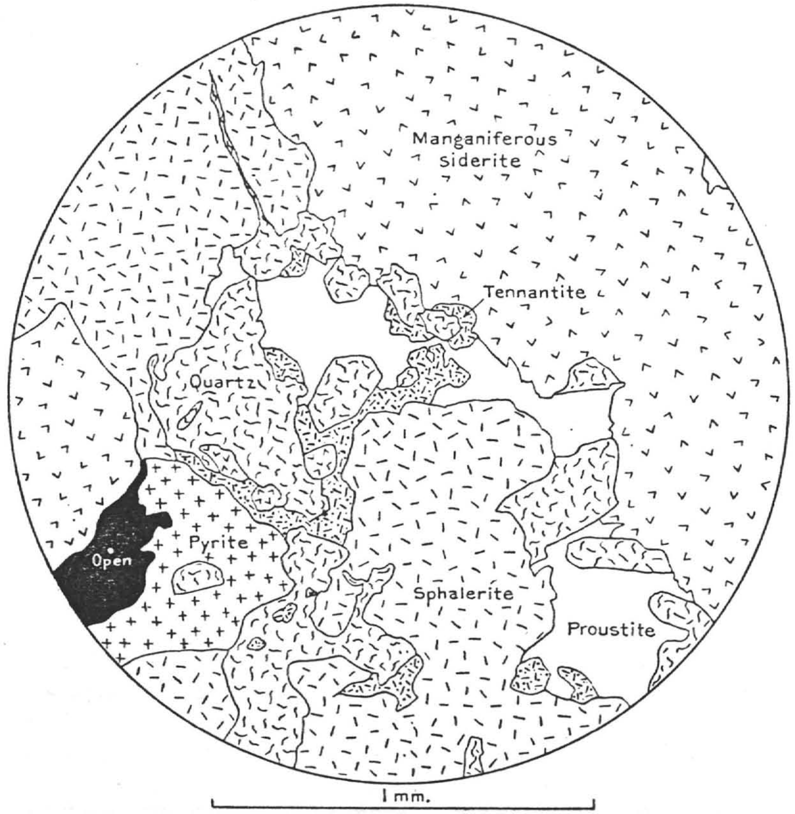


FIGURE 10.—Primary intergrowth of proustite with tennantite, sphalerite, etc., Mineral Park, Ariz.

## UNSPECIFIED ORES FROM MINERAL PARK.

A very fine specimen of rich proustite ore from Mineral Park was presented by Mrs. Kay, of that place, but she was unable to specify more closely the exact source of the material. The minerals recognized in this ore, all primary (hypogene), are quartz, pyrite, galena, sphalerite, manganiferous siderite, tennantite, and proustite.

All these minerals appear to have been deposited during a single period of primary mineralization, but pyrite appears to have been



the first mineral deposited, and some fracturing of it occurred prior to the deposition of the other ore minerals. As in most of the ores of Mineral Park the proustite is clearly associated with tennantite, a relation which suggests that it may replace tennantite. Close examination, however, shows that the tennantite nearly everywhere has sharp crystal faces next to proustite, as shown in Figure 10 and on a larger scale in Figure 11. The proustite can not have replaced tennantite and is interpreted as primary (hypogene). The galena when tarnished brown with hydrogen peroxide, a reagent that does not tarnish silver minerals, shows no evidence of replacement by other minerals to more than the most incipient degree. The proustite is never found along galena contacts or cleavages.

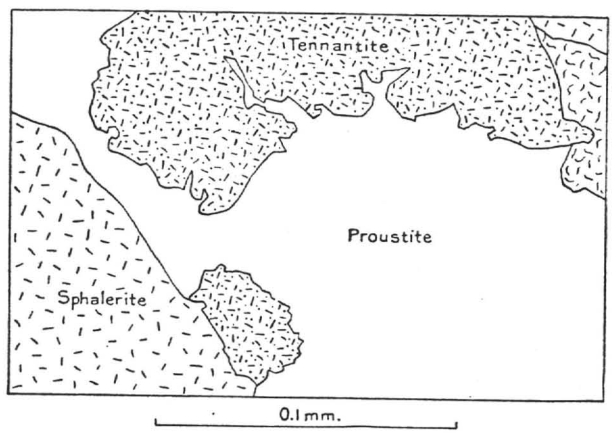


FIGURE 11.—Primary association of proustite and tennantite, Mineral Park, Ariz.

## MINES NEAR STOCKTON HILL.

The mining camp of Stockton Hill is about 9 miles north-northwest of Kingman, near the south end of the Cerbat Range and on its east slope. It lies within the area of pre-Cambrian gneiss and schist. In 1913 all the mines had been idle for many years, but some old mine dumps were examined. According to Schrader[7] the district was noted for its rich minerals—cerargyrite, native silver, argentite, and proustite—found in the upper portions of its mines. The water level stood commonly at a depth of about 100 feet.

At the Cupel mine the dump is very old, and the workings are caved, operations having ceased in 1891. The output of the mine is variously estimated at $500,000 to $1,500,000, chiefly in silver. According to Schrader[8] some of the ruby silver ore averaged 3,000

[7] Op. cit., p. 108.

[8] Op. cit., p. 111.

ounces of silver to the ton. Cerargyrite and argentite were found in some of the ore.

Specimens collected by the writer from the old dumps and one especially rich specimen of unoxidized ore presented by Mr. H. H. Watkins, of Kingman, showed the following minerals:

Primary (hypogene): Quartz (usually gray and fine grained), pyrite, arsenopyrite, galena, sphalerite, siderite, chalcopyrite, tennantite, proustite, pearceite.
Secondary (supergene): Proustite and argentite, both very rare.

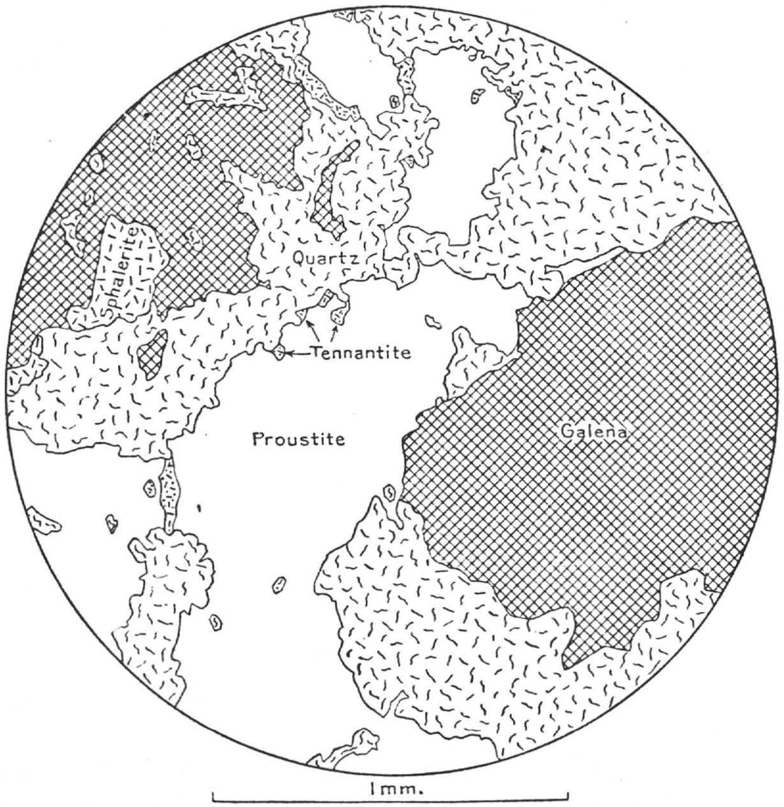


FIGURE 12.—Primary proustite in association with galena, tennantite, and quartz, Cupel mine, Stockton Hill, Ariz.

In the specimen presented by Mr. Watkins proustite constitutes fully half of the volume of the ore throughout an ill-defined band 1½ inches wide. Microscopic study of this specimen fails to disclose any evidence that the proustite either fills fractures in older minerals or has replaced them. The mineral commonly most susceptible to replacement by silver minerals in downward enrichment is galena. In this ore, however, there is no indication that galena has been replaced by proustite. On the contrary, the two minerals occur side by side in areas of comparable size, as shown in Figure 12.



Tennantite is present in small amounts and here, as in the ores of Mineral Park and Chloride, is particularly intimately associated with proustite, usually forming small patches within the proustite. These patches of tennantite are not, however, replacement remnants, because they are as likely to occur at the border of proustite areas as in their interior and because they commonly show crystal outlines characteristic of tennantite. If tennantite had been replaced by proustite the original crystal outlines would have been destroyed. Added evidence that proustite has not replaced tennantite is found in the localization of some tennantite crystals along the contact between two crystals of proustite; such a relation is not explainable on the assumption that proustite has replaced tennantite but is readily understood if the two minerals crystallized at about the same time. In places proustite carries abundant inclusions of quartz and of chalcopyrite, both of which show crystal outlines.

Though nearly all the proustite in the ores of the Cupel mine is interpreted as primary (hypogene), one specimen of partly oxidized ore from the dump showed very thin films of argentite and of proustite, with dendritic outlines, along a small fracture. These minerals are very probably secondary (supergene), but they are quantitatively of almost negligible importance. This mode of occurrence of proustite is in marked contrast to that of the proustite which is intercrystallized with the primary ore minerals.

## SUMMARY AND CONCLUSIONS.

The minerals noted in the silver ores of the Cerbat Mountains, between Kingman and Chloride, Ariz., are listed below. Those marked with an asterisk (*) are rare under the conditions indicated.

Oxidation products: Cerargyrite (horn silver), native silver, *copper pitch ore, *malachite, *native copper.
Products of downward sulphide enrichment: Argentite, *proustite (very rare), *covellite, *chalcocite.
Primary (hypogene) minerals: Quartz (usually gray and finely crystalline), manganiferous siderite, *calcite (white), pyrite, arsenopyrite, sphalerite, galena, chalcopyrite, tennantite, *argentite, proustite, pearceite, *polybasite.

It is noteworthy that the ores are prevailingly arsenical, with four arsenic minerals, arsenopyrite, tennantite, proustite, and pearceite. Only in one specimen were small amounts of an antimony mineral (polybasite) noted.

The unoxidized ores are in general fine grained and compact. Vugs are few and small. Because of this compactness oxidation above the ground-water level is very commonly incomplete, being confined to the vicinity of fractures that traverse the ore. Ore specimens several inches across essentially unoxidized may in places be found within a few feet of the outcrop. Heavily limonite-stained gossans or "iron caps" are not characteristic.

The ground-water level stood at depths of 25 to 250 feet in the mines studied. A test of stream water near Chloride showed the high chlorine content (80 parts per million) usual in desert regions.

According to Schrader the dominant silver mineral in the ores found close to the surface was usually cerargyrite. No specimens of these ores were obtainable for study. In this area, as elsewhere, cerargyrite is confined to the oxidized zone.

Native silver appears to have been most abundant at slightly greater depths than those at which cerargyrite was dominant—that is, close to the surface native silver is dissolved and partly reprecipitated as cerargyrite by chloride-bearing waters. Native silver appears to have been confined mainly to the oxidized zone in the vicinity of vugs and fractures. A little may have been deposited a short distance below the ground-water level. Some of the silver has replaced proustite, as shown in Figure 3. It was also noted replacing polybasite, pearceite, and argentite. In places the silver forms tapering and curling "teeth" attached to these minerals and obviously formed by their alteration. Some such silver "teeth" are in contact with older crystals of calcite that are unetched, indicating that the silver was not deposited from acid solutions. The manganiferous siderite and calcite present in most of the veins would insure the prompt neutralization of acidity developed in solutions descending through the oxidized zone. Schrader[9] mentions the occurrence in the Distaff mine of slabs of native silver many pounds in weight.

Chalcocite is not abundant, but it was noted along fractures in granite near the King vein, in Mineral Park. It contained remnants of pyrite and was evidently formed by the replacement of pyrite. In places a little native copper is associated with this chalcocite and probably represents a residuum after the oxidation of the sulphur of the chalcocite.

Argentite, though not abundant, occurs in two contrasting ways—in scattered, thin fungus-like scales or patches along fractures in unoxidized or only slightly oxidized ore and in small but well-formed octahedral crystals occurring side by side with crystals of proustite and pearceite in small vugs in unoxidized ore. Some of this argentite is intercrystallized with small amounts of chalcopyrite and sphalerite, and on some of the argentite small crystals of later quartz are implanted. It is probable that the argentite occurring in octahedral crystals is primary (hypogene); that occurring in scales or patches is very probably supergene, a product of downward enrichment.

Downward (supergene) sulphide enrichment, or the deposition of sulphides below the ground-water level by solutions descending from

[9] Op. cit., p. 60.



the oxidized zone, appears to have been of nearly negligible importance in these ores. The supposedly supergene argentite mentioned above is present in only small amounts. In one specimen of ore from the Cupel mine, at Stockton Hill, very thin films of argentite and of proustite, dendritic in form, occurring along small fractures cutting primary ore, are believed to be secondary (supergene). Quantitatively such occurrences are negligible, and most of the proustite, for reasons enumerated below, is believed to be primary (hypogene). Very slight downward enrichment in copper was shown in some specimens by peripheral replacement of pyrite by chalcocite and of chalcopyrite and sphalerite by covellite.

Proustite, or light ruby silver, is the only abundant silver mineral of the unoxidized ore, although pearceite, polybasite, and argentite also occur. In some specimens studied masses 1 or 2 inches across are mainly proustite, and masses of pure proustite as large as the end of a man's thumb were noted. Such proustite is believed to be primary (hypogene), and the evidence for this opinion will next be summarized.

1. Masses of proustite as large as the end of a thumb and with well-developed crystal faces were noted intercrystallized with the undoubtedly primary minerals quartz, sphalerite, pyrite, and ferruginous calcite—all having apparently been deposited at about the same time.

2. In one specimen studied small areas of proustite are wholly inclosed by calcite that forms the lining of vugs. Elsewhere well-formed crystals of proustite are coated with calcite. There is no evidence that this calcite has been deposited by descending (supergene) solutions.

3. Relatively large unmixed areas of proustite in a granular aggregate of ore minerals must either be primary (hypogene) or the product of complete replacement of older minerals. In places, however, such proustite areas are adjacent to chalcopyrite and sphalerite that show only incipient peripheral replacement by covellite. Such incipient replacement by covellite would hardly be expected to occur side by side with complete replacement of relatively large masses of some hypothetical mineral by proustite. It is more probable that the proustite was formed not by replacement but by primary crystallization.

4. In all the ores studied proustite is more intimately associated with tennantite than with any other mineral. Proustite is the sulpharsenide of silver; tennantite is the sulpharsenide of copper. The proustite has not, however, replaced tennantite, for the tennantite nearly everywhere has its own characteristic crystal outlines, as shown in Figures 2, 5, 9, and 10. Added evidence that proustite has not replaced tennantite is furnished by the fact that certain

areas of tennantite carry only scattered small inclusions of sphalerite, whereas bordering areas of proustite are crowded with relatively large sphalerite inclusions.

5. The presence of inclusions of sphalerite and chalcopyrite in both tennantite and proustite is itself suggestive of a primary origin for the proustite, because sphalerite, chalcopyrite, and tennantite are exceedingly rare as products of secondary (supergene) enrichment.

6. Galena, fairly abundant in these ores, is a mineral that is usually particularly susceptible to replacement by silver minerals in the processes of downward enrichment. Where galena and proustite are found together in these ores they commonly occur side by side without evidence of replacement. Figure 4 shows an association of sphalerite and proustite in contact with galena. The smooth galena contacts extending from proustite to sphalerite indicate either simultaneous replacement of galena by proustite and sphalerite or an absence of replacement, the three minerals all being essentially of the same age and primary. Simultaneous replacement of galena by an intergrowth of proustite and sphalerite is highly improbable and if it occurred would almost certainly be a part of the process of primary (hypogene) mineralization, for the deposition of sphalerite in the downward enrichment of ore deposits is exceedingly rare. In Figure 7 are shown small areas of proustite inclosed by galena. If these were formed by replacement of the galena, they should be related to the galena cleavages, but they show no such relation and are interpreted as inclusions of primary proustite in galena. A single possible exception to the general rule that proustite has not replaced galena is illustrated in Figure 8. This figure was drawn from a specimen which in most places shows the relations illustrated in Figures 4 and 7. The veinlets are interpreted as fillings of a fracture in galena by primary proustite, possibly combined with very slight primary replacement of the galena by the proustite. Such relations are very exceptional. Additional evidence that proustite has not replaced galena is found in the common presence of many small inclusions of sphalerite and chalcopyrite in proustite and the absence of such inclusions from adjacent galena. It can not be assumed that the proustite has replaced galena unless sphalerite and chalcopyrite have replaced it simultaneously.

7. In some ores proustite and pearceite intergrown with tennantite possess regular crystal outlines, as shown in Figure 9. The narrow white areas in this figure are pearceite showing its own characteristic tabular crystal forms (lath-shaped in cross section); the larger white areas are mostly pearceite. Sulphides occasionally develop their own crystal form in replacing other sulphides, but the relation seems to be rare. In ores from the Mowry mine, in the Patagonia district, Ariz., the writer has observed radiating groups of tabular crystals of covellite replacing galena. The development of the covellite was, however, clearly controlled by cleavage planes of the galena or by contacts of galena with other minerals. In the association of pearceite and tennantite under description there is no such relation of the pearceite to tennantite contacts or partings, but the pearceite appears to be fairly evenly distributed through the tennantite. The two are interpreted as in primary intergrowth. There is no evidence that the proustite of this specimen is the result of a replacement of pearceite; it appears rather to be contemporaneous. On theoretical grounds the supergene replacement of pearceite ($9Ag_2S.As_2S_3$), a rich silver mineral, by proustite ($3Ag_2S.As_2S_3$), a mineral poorer in silver, is unlikely, for it would involve a reversal of the progression to richer silver minerals characteristic of the process of downward silver enrichment.



Although some of the relations outlined above taken singly would not form conclusive evidence that the proustite was primary, taken collectively their signifiance is unescapable.

The possibility of profitable operation of any particular deposit in this area is dependent upon many considerations, among which may be mentioned the price of silver, costs of transportation and labor, milling and smelting facilities, the width and horizontal extent of the ore body, the primary distribution of silver minerals within the vein, and the nature and extent of downward enrichment in silver.

Some of the richest silver ores of the area, carrying cerargyrite and native silver, were unquestionably products of oxidation and downward enrichment, and the playing out of these ores in depth was certainly an important factor in the closing down of many of the mines. The decline in the price of silver from 1872 to 1916 was unquestionably an added discouraging factor.

The conclusion that the rich ruby silver ores of the region are in the main primary offers encouragement to further exploration of the ore bodies, although this work should be undertaken only with due regard to the many other and perhaps unfavorable factors involved. A general decrease in the primary silver content of veins of this type with increase in depth is probable, but such primary changes are likely to be much less abrupt than those due to downward enrichment and to be recognizable only through vertical intervals measured in many hundreds rather than a few hundreds of feet. The depth of most of the mines is too small to afford any valid test of this factor, even had the workings been accessible for study. Underground studies, had they been possible, would have aided in determining whether the rich primary proustite ores were of spotty or patchy distribution, or of fairly regular distribution within the veins, a question of fundamental practical importance.

PRODUCTION OF BENTLEY DISTRICT, MOHAVE COUNTY
1908-17

| Year | Producers | | Tons | Gold (value) | Silver (ounces) | Copper (pounds) | Lead (pounds) | Zinc (pounds) | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1908 | 1 | — | 538 | — | *2,000* | *300,000* | — | — | $ 40,000 |
| 1909 | 1 | — | 500 | — | 1,720 | 299,154 | — | — | 39,784 |
| 1910 | 1 | — | *800* | — | 2,839 | 489,536 | — | — | 63,875 |
| 1911 | 1 | — | *320* | — | *500* | *200,000* | — | — | *25,000* |
| 1912 | 1 | — | 1,152 | — | *400* | *700,000* | — | — | *116,000* |
| 1913 | 2 | — | 1,982 | — | *600* | *700,000* | — | — | *110,000* |
| 1914 | 3 | — | 1,473 | — | *500* | *715,000* | — | — | 95,522 |
| 1915 | 3 | — | 1,542 | — | *750* | *750,000* | — | — | 132,335 |
| 1916 | 5 | — | 3,797 | — | *1,500* | *1,070,000* | — | — | 265,820 |
| 1917 | 3 | — | 2,939 | — | 1,405 | 813,531 | — | — | 223,252 |
| Total | | | 15,043 | — | 12,214 | 6,037,221 | — | — | $1,111,588 |

PRODUCTION OF SAN FRANCISCO DISTRICT, MOHAVE COUNTY
1908-33

| Year | Producers | | Tons | Gold (value) | Silver (ounces) | Copper (pounds) | Lead (pounds) | Zinc (pounds) | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1908 | 6 | — | 72,757 | $ 266,254 | 6,522 | — | — | — | $ 269,712 |
| 1909 | 3 | — | 18,106 | 300,036 | 7,118 | — | — | — | 303,737 |
| 1910 | 5 | — | 89,284 | 1,103,221 | 26,254 | — | — | — | 1,117,398 |
| 1911 | 8 | — | 110,699 | 1,458,639 | 33,834 | — | — | — | 1,476,571 |
| 1912 | 3 | — | 174,319 | 1,794,847 | 41,456 | — | — | — | 1,820,342 |
| 1913 | 5 | — | 159,948 | *1,797,282* | *35,000* | — | — | — | 1,818,522 |
| 1914 | 10 | — | 160,469 | *1,827,633* | *35,000* | — | — | — | 1,846,998 |
| 1915 | 11 | — | 132,579 | *1,483,823* | *30,000* | — | — | — | 1,499,033 |
| 1916 | 5 | — | 94,615 | 892,681 | 23,812 | — | — | — | 908,349 |
| 1917 | 4 | — | 167,258 | 2,310,270 | 57,353 | — | — | — | 2,357,529 |
| 1918 | 11 | — | 182,824 | 2,772,991 | 70,432 | — | — | — | 2,843,423 |
| 1919 | 6 | — | 184,490 | 2,556,197 | 71,833 | — | — | — | 2,636,650 |
| 1920 | 6 | — | 197,629 | 2,830,731 | 92,806 | — | — | — | 2,931,890 |
| 1921 | 4 | — | 179,013 | *2,308,050* | *80,000* | — | — | — | 2,388,050 |
| 1922 | 10 | — | 169,240 | *1,078,546* | *60,000* | — | — | — | 2,138,546 |
| 1923 | 12 | — | 186,686 | 2,796,830 | 68,551 | — | — | — | 2,853,042 |
| 1924 | 14 | — | 96,776 | 1,617,196 | 39,097 | — | — | — | 1,643,391 |
| 1925 | 11 | — | 33,826 | 503,019 | 11,721 | — | — | — | 510,153 |
| 1926 | 12 | — | 29,721 | 395,971 | 9,964 | — | — | — | 402,188 |
| 1927 | 11 | — | 15,028 | 147,599 | 4,708 | — | — | — | 150,268 |
| 1928 | 11 | — | 11,817 | 147,389 | 4,152 | — | — | — | 149,818 |
| 1929 | 7 | — | 4,430 | 118,516 | 4,068 | — | — | — | 120,684 |
| 1930 | 11 | — | 28,048 | 580,768 | 18,274 | — | — | — | 587,803 |
| 1931 | 11 | — | 45,414 | 706,767 | 21,771 | 276 | — | — | 713,106 |
| 1932 | 18 | 1 | 5,364 | 71,410 | 2,032 | — | — | — | 71,983 |
| 1933 | 9 | 3 | 22,683 | 161,272 | 5,437 | — | — | — | 163,175 |
| Total | | | 2,573,023 | $32,026,938 | 861,195 | 276 | — | — | $33,722,361 |



PRODUCTION OF WALLAPAI DISTRICT, MOHAVE COUNTY
1908-33

| Year | Producers | | Tons | Gold (value) | Silver (ounces) | Copper (pounds) | Lead (pounds) | Zinc (pounds) | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1908 | 22 | ---- | 2,179 | $ 24,664 | 29,931 | 11,920 | 249,328 | 505,133 | $ 76,313 |
| 1909 | 18 | ---- | 11,658 | 48,595 | 69,966 | 1,774 | 113,112 | 5,264,121 | 374,335 |
| 1910 | 25 | ---- | *10,000* | *50,000* | *70,000* | 20,341 | 235,368 | 5,474,046 | *390,000* |
| 1911 | 25 | ---- | 28,672 | 79,602 | 109,304 | 27,652 | 2,564,673 | 4,476,552 | 511,565 |
| 1912 | 26 | ---- | 26,528 | 94,843 | 131,222 | 209,100 | 1,936,760 | 8,304,462 | 870,209 |
| 1913 | 22 | ---- | 42,967 | 70,224 | 202,282 | 31,072 | 5,312,754 | 7,031,400 | 824,738 |
| 1914 | 17 | ---- | 40,517 | 57,331 | 123,365 | 18,297 | 3,708,102 | 9,553,050 | 759,306 |
| 1915 | 10 | ---- | 85,635 | 107,550 | 243,819 | 46,171 | 6,452,406 | 17,382,849 | 2,697,982 |
| 1916 | 21 | ---- | 104,658 | 126,241 | 229,237 | 190,807 | 5,825,791 | 17,024,626 | 3,007,298 |
| 1917 | 29 | ---- | 104,362 | 144,959 | 294,197 | 84,394 | 6,087,742 | 17,127,596 | 2,680,978 |
| 1918 | 26 | ---- | 2,018 | 19,926 | 38,332 | 27,738 | 523,805 | 82,853 | 116,346 |
| 1919 | 21 | ---- | 3,352 | 18,045 | 44,531 | 90,990 | 504,095 | — | 111,651 |
| 1920 | 15 | ---- | 2,399 | 14,115 | 37,500 | 11,160 | 338,623 | — | 84,133 |
| 1921 | 6 | ---- | 10,206 | 20,876 | 82,947 | 15,855 | 278,321 | — | 118,393 |
| 1922 | 14 | ---- | 3,453 | — | — | — | — | — | 61,234 |
| 1923 | 12 | ---- | 1,150 | — | — | — | — | — | — |
| 1924 | 17 | ---- | 388 | — | — | — | — | — | — |
| 1925 | 22 | ---- | 3,169 | 15,675 | 38,744 | 26,646 | 341,646 | 174,703 | 89,346 |
| 1926 | 28 | ---- | 10,056 | 42,055 | 75,470 | 80,728 | 697,805 | 1,669,266 | 281,469 |
| 1927 | 20 | ---- | 19,289 | *80,000* | *60,000* | *35,000* | *600,000* | 1,186,826 | *230,000* |
| 1928 | 14 | ---- | 995 | 4,102 | 10,770 | 10,450 | 43,791 | 150,319 | 23,617 |
| 1929 | 17 | ---- | 1,849 | 6,171 | 10,224 | 19,393 | 64,296 | 133,414 | 27,889 |
| 1930 | 5 | ---- | 342 | 2,130 | 4,181 | 2,411 | 37,640 | 35,104 | 7,620 |
| 1931 | 3 | ---- | 103 | 328 | 253 | 581 | — | — | 454 |
| 1932 | 5 | ---- | 236 | 4,001 | 3,553 | 2,333 | 17,500 | — | 5,675 |
| 1933 | 9 | ---- | 333 | 6,035 | 3,517 | 1,422 | 56,946 | 11,024 | 9,927 |
| Total | | | 516,514 | $1,037,468 | 1,913,345 | 966,235 | 35,990,504 | 95,587,344 | $13,360,978 |

PRODUCTION OF AJO DISTRICT, PIMA COUNTY
1909-33

| Year | Producers | | Tons | Gold (ounces) | Silver (ounces) | Copper (pounds) | Lead (pounds) | Zinc (pounds) | Total value |
|---|---|---|---|---|---|---|---|---|---|
| | Lode | Placer | | | | | | | |
| 1909 | 4 | ---- | 810 | $ 3,401 | 894 | 142,516 | — | — | $ 22,393 |
| 1910 | 5 | ---- | 926 | 517 | 421 | 97,999 | — | — | 13,190 |
| 1911 | 2 | ---- | — | — | — | *100,000* | — | — | 12,500 |
| 1912 | 1 | ---- | — | — | — | *100,000* | — | — | 16,500 |
| 1913 | — | ---- | — | — | — | — | — | — | — |
| 1914 | — | ---- | — | — | — | — | — | — | — |
| 1915 | 5 | ---- | 94 | — | — | *20,000* | — | — | 3,611 |
| 1916 | — | ---- | *40,000* | — | — | *1,000,000* | — | — | *246,000* |
| 1917 | 11 | ---- | 801,026 | 852 | 6,754 | 20,201,645 | — | — | 5,521,466 |
| 1918 | 1 | ---- | 1,856,417 | — | — | 49,950,139 | — | — | 12,360,220 |
| 1919 | 1 | ---- | 1,604,653 | — | — | 39,509,461 | — | — | 7,348,760 |
| 1920 | 1 | ---- | 1,743,439 | — | — | 40,104,493 | — | — | 7,379,227 |
| 1921 | 1 | ---- | 931,051 | — | — | 20,198,382 | — | — | 2,605,591 |
| 1922 | 1 | ---- | 1,339,757 | — | — | 26,612,803 | — | — | 3,592,728 |
| 1923 | 1 | ---- | 1,805,322 | — | — | 38,367,718 | — | — | 5,640,055 |
| 1924 | 1 | ---- | 2,984,862 | 220,672 | 162,068 | 63,884,293 | — | — | 8,711,556 |
| 1925 | 1 | ---- | 3,346,770 | 296,763 | 209,860 | 69,262,286 | — | — | 10,277,626 |
| 1926 | 1 | ---- | 3,405,174 | 376,516 | 234,139 | 82,312,463 | — | — | 12,044,264 |
| 1927 | 1 | ---- | 3,371,261 | 379,289 | 200,924 | 72,932,670 | — | — | 9,897,892 |
| 1928 | 1 | ---- | 3,646,029 | 338,580 | 171,943 | 77,995,281 | — | — | 11,825,915 |
| 1929 | 1 | ---- | 2,456,304 | 304,682 | 155,739 | 71,000,000 | — | — | 12,768,387 |
| 1930 | 1 | ---- | 1,916,932 | 236,568 | 121,300 | 50,474,000 | — | — | 6,844,431 |
| 1931 | 1 | ---- | *1,635,000* | *290,000* | *150,000* | *41,200,000* | — | — | 4,082,005 |
| 1932 | 1 | 1 | *350,000* | *70,000* | *25,000* | *10,000,000* | — | — | *637,000* |
| 1933 | — | 1 | — | 294 | — | — | — | — | 294 |
| Total | | | 33,235,827 | $2,518,134 | 1,439,042 | 775,466,149 | — | — | $121,851,611 |

# The Wallapai Mining District Cerbat Mountains Mohave County Arizona

*By* McCLELLAND G. DINGS

CONTRIBUTIONS TO ECONOMIC GEOLOGY, 1951

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W. E. Wrather, *Director*

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By McClelland G. Dings

### ABSTRACT

The Wallapai mining district is in Mohave County, northwestern Arizona, near the center of the Cerbat Mountains. The district is approximately 10 miles long and 4 miles wide. In the early days (1863–1900) miners sought silver, and to a less extent gold, in the oxidized parts of the fissure veins. Later, lead with a low silver content was mined, and still later the zinc and lead production became the most valuable, owing very largely to the combined output of the Golconda and Tennessee mines. From 1904 to 1948 the district had a recorded recovery of 54,760 tons of zinc and 35,736 tons of lead.

The rocks include granites, gneisses, schists, and amphibolite of pre-Cambrian age intruded by two younger masses of granite. The older of these two granite intrusions is in the northern part of the district and is named the "Chloride granite" in this report. It is probably of pre-Cambrian age. The other intrusion, the Ithaca Peak granite, is near the center of the district. In this report it is assigned a Mesozoic (?) age, although it had previously been designated as Tertiary (?). Gneissic granites predominate throughout the district. Dikes of pegmatite, rhyolite, and lamprophyre are abundant and widespread. Remnants of volcanic rocks of probable Tertiary and Quaternary age flank the Cerbat Mountains but are not present in the district.

The structural history has been complex. Most of the rocks, except the large Mesozoic (?) granite intrusion, are gneissoid or schistose. The prevailing schistosity strikes northeast, with steep dips either to the northwest or to the southeast. A large northeastward-trending fold occurs near Chloride; other, less prominent ones are indicated on the map. The veins occupy fissures in a very prominent and persistent northwestward-trending zone. Postmineral faulting offsetting the veins is rare and where present has resulted in only minor displacements.

The typical ore occurs in pyritic quartz veins and lodes formed at intermediate depths. Veins range considerably in thickness but average 3 to 4 feet. Only a few exceed a length of 1 mile. The oxidized zone, averaging 150 feet in depth, commonly contains cerargyrite, native gold, galena, and cerussite. The primary ore consists chiefly of sphalerite, galena, pyrite, and some chalcopyrite. The sulfides occur in irregular masses and in crudely banded forms in quartz gangue. Ore shoots vary greatly in size, but the smaller ones, averaging about a foot in thickness and 20 feet in length and breadth, predominate. Primary enriched zones are commonly, though not always, found at abrupt changes in the strike of the veins and also at the junctions of branch veins. Mineralization took place probably in the Mesozoic, and the solutions probably are genetically related to a granite intrusion exposed near the central part of the district.

# INTRODUCTION

## LOCATION AND ACCESSIBILITY

The Wallapai (Hualpai) mining district is in Mohave County in the northwestern part of Arizona (fig. 45). It occupies the central part of the Cerbat Mountains, which extend north-northwestward from Kingman for about 30 miles. The Wallapai district is about 10 miles long and 4 miles wide, trending northwestward obliquely across the mountains. The district includes the mining camps of Chloride, Mineral Park, Cerbat, and Stockton as well as outlying and intermediate areas such as Union Basin, Todd Basin, C. O. D. Wash, and I. X. L. Wash. All the camps are practically deserted except Chloride, which has a population of about 620 (1943 estimate by local

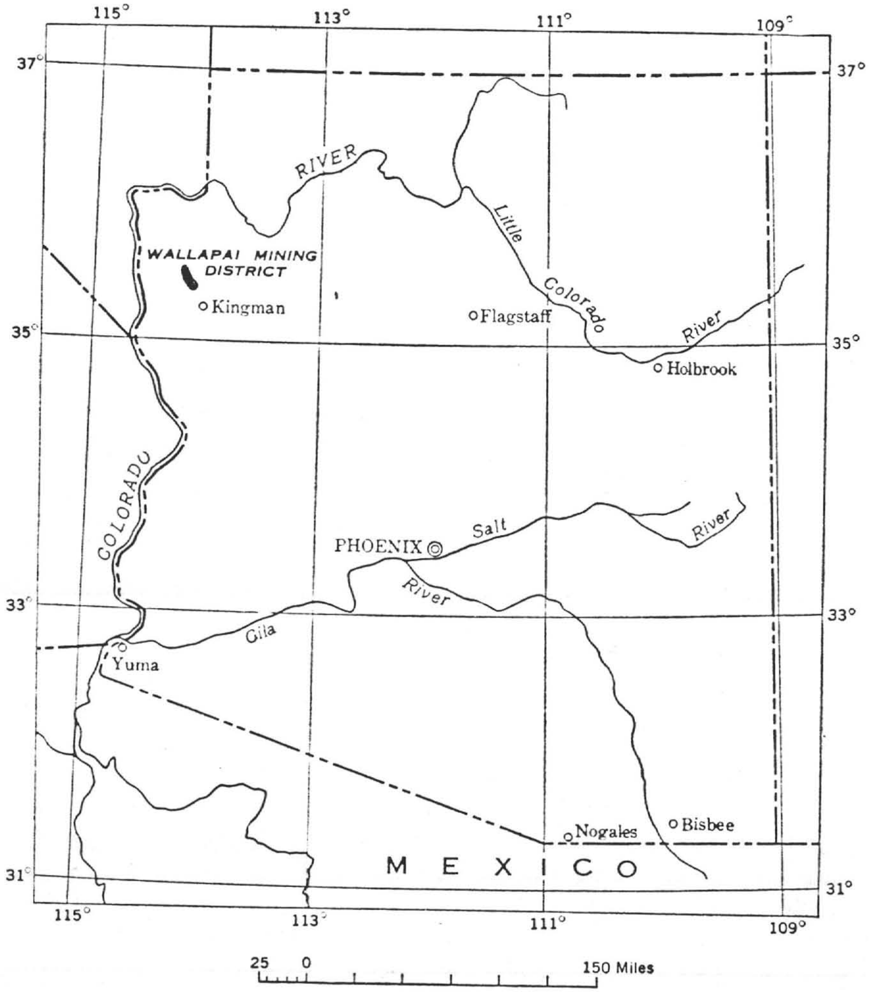


FIGURE 45.—Index map showing the location of the Wallapai mining district, Arizona.



postmaster). With the exception of those in the Stockton area, most of the mines are on the western slope of the mountains.

The nearest railroad station is at Kingman, reached from Chloride by a good paved road 24 miles long. Numerous dirt roads, generally in fair condition, extend to, or near, many of the mines.

## TOPOGRAPHY

The topography is typical of eroded granite and gneiss masses in the more arid parts of the Southwest. The Cerbat Mountains rise sharply from the detritus-filled valleys bordering them on the east and west. The relief in the district amounts to about 3,500 feet: the lowest point is in Sacramento Valley in the southwestern part of the area, and the highest point is Cherums Peak (altitude 6,973 feet).

## CLIMATE AND VEGETATION

The climate is arid, with mild winters and hot summers. The average temperature of the summer months is high, but the heat is allayed by cool nights, low humidity, and a more or less constant breeze. The annual precipitation is low. It is chiefly rain except in the higher mountains where snow falls in winter, but usually most of the snow melts within a short time. In summer the precipitation is largely concentrated in cloudbursts. Mining operations can be carried on throughout the year.

Vegetation is sparse and of the desert type, being confined largely to the valleys and lower slopes of the mountains. It consists chiefly of cacti, sage, yuccas, greasewood, soapweed, and a scanty growth of grasses. Scrub piñon or juniper is found in open groves and is particularly abundant in Mineral Park.

## HISTORY AND PRODUCTION

Many of the mines were discovered between 1863 and 1900 by prospectors in quest of the silver and gold which occurred in the oxidized parts of the fissure veins, the silver commonly in very rich concentrations. Cerargyrite, argentite, galena, and some gold were the principal ore minerals recovered in the early days. Improvement in transportation facilities and milling methods led to the subsequent production of base-metal ores. At first, lead with a low silver content was mined, but later the production of zinc and lead exceeded in value that of all other metals in the district.

The value of the metals produced during the years 1904–48 (table 1) totals about $22,500,000. The value prior to 1904 is not known, but it probably amounted to at least five million dollars, for much high-grade silver ore, and to a less extent gold ore, is reported to have been mined in the early days.

TABLE 1.—*Production of gold, silver, copper, lead, and zinc in the Wallapai district, Mohave County, Ariz., 1904–48, in terms of recovered metals*

[Compiled by Metal Economics Branch, U. S. Bureau of Mines, Salt Lake City, Utah]

| Year | Crude ore produced (dry tons) | Gold (oz.) | Silver (oz.) | Copper (lbs.) | Lead (lbs.) | Zinc (lbs.) | Value (dollars) |
|---|---|---|---|---|---|---|---|
| 1904 | 1,531 | 1,592.42 | 64,335 | 1,480 | 6,036 | ------ | ------ |
| 1905 | 5,868 | 1,137.00 | 58,751 | 173 | 112,266 | ------ | 64,294 |
| 1906 | 9,946 | 2,772.00 | 125,331 | 114,502 | 904,390 | ------ | ------ |
| 1907 | 13,013 | 5,358.62 | 58,895 | 62,917 | 1,229,654 | 30,666 | 229,206 |
| 1908 | 2,179 | 1,193.13 | 29,931 | 11,920 | 249,328 | 505,133 | 76,313 |
| 1909 | 11,658 | 2,350.77 | 69,966 | 1,774 | 113,112 | 5,264,121 | 374,335 |
| 1910 | 1,109 | 424.33 | 48,509 | 20,341 | 235,368 | ------ | 47,908 |
| 1911 | 12,692 | 2,735.75 | 71,233 | 27,428 | 2,394,629 | 960,097 | 260,220 |
| 1912 | 4,472 | 1,461.87 | 43,761 | 7,828 | 1,350,920 | 799,219 | 174,362 |
| 1913 | 32,933 | 2,588.27 | 177,853 | 30,782 | 5,171,988 | 4,233,642 | 630,350 |
| 1914 | 22,492 | 1,205.41 | 88,951 | 18,297 | 3,708,102 | 4,932,108 | 472,695 |
| 1915 | 85,635 | 5,202.75 | 243,819 | 46,171 | 6,452,406 | 17,382,849 | 2,697,982 |
| 1916 | 104,658 | 6,106.90 | 229,237 | 190,807 | 5,825,791 | 17,024,626 | 3,007,298 |
| 1917 | 104,362 | 7,012.38 | 294,197 | 84,394 | 6,087,742 | 17,127,596 | 2,680,978 |
| 1918 | 4,739 | 987.82 | 42,098 | 91,596 | 533,462 | 82,853 | 130,558 |
| 1919 | 3,352 | 872.91 | 44,531 | 90,990 | 504,095 | ------ | 111,561 |
| 1920 | 2,399 | 682.81 | 37,500 | 11,160 | 338,623 | ------ | 84,133 |
| 1921 | 10,206 | 1,009.88 | 82,947 | 15,855 | 278,321 | ------ | 118,393 |
| 1922 | 3,453 | 553.94 | 42,099 | 22,638 | 84,142 | ------ | 61,234 |
| 1923 | 1,150 | 235.81 | 25,843 | 21,550 | 11,620 | ------ | 30,047 |
| 1924 | 388 | 165.30 | 5,027 | 6,460 | 172,088 | ------ | 21,398 |
| 1925 | 3,169 | 758.29 | 38,744 | 26,646 | 341,646 | 174,703 | 89,346 |
| 1926 | 10,056 | 2,034.39 | 75,470 | 80,728 | 697,805 | 1,669,266 | 281,469 |
| 1927 | 19,289 | 837.17 | 49,499 | 37,220 | 696,086 | 1,184,454 | 169,906 |
| 1928 | 995 | 198.45 | 10,770 | 10,450 | 43,791 | 150,319 | 23,617 |
| 1929 | 1,849 | 298.54 | 10,224 | 19,393 | 64,296 | 133,414 | 27,889 |
| 1930 | 342 | 103.06 | 4,181 | 2,411 | 37,640 | 35,104 | 7,620 |
| 1931 | 103 | 15.88 | 253 | 581 | ------ | ------ | 454 |
| 1932 | 236 | 193.55 | 3,553 | 2,333 | 17,500 | ------ | 5,675 |
| 1933 | 333 | 236.11 | 3,517 | 1,422 | 56,946 | 11,024 | 9,927 |
| 1934 | 1,057 | 223.69 | 4,718 | 2,737 | 11,514 | 10,698 | 11,973 |
| 1935 | 14,775 | 1,665.20 | 76,519 | 26,506 | 140,725 | 133,205 | 126,970 |
| 1936 | 36,185 | 5,782.00 | 193,763 | 107,859 | 1,681,478 | 1,047,960 | 491,334 |
| 1937 | 119,246 | 15,348.00 | 528,640 | 400,182 | 4,978,220 | 3,428,354 | 1,511,063 |
| 1938 | 109,810 | 15,027.00 | 560,518 | 311,163 | 4,007,239 | 3,319,812 | 1,262,478 |
| 1939 | 68,716 | 9,301.00 | 451,325 | 146,077 | 1,406,553 | 1,539,692 | 793,253 |
| 1940 | 76,317 | 8,135.00 | 284,760 | 224,221 | 4,607,480 | 8,589,000 | 1,284,039 |
| 1941 | 70,398 | 7,500.00 | 213,577 | 132,700 | 4,816,200 | 4,692,000 | 1,056,459 |
| 1942 | 70,533 | 5,406.00 | 157,112 | 136,800 | 3,312,600 | 4,487,700 | 956,787 |
| 1943 | 43,724 | 1,922.00 | 88,695 | 236,500 | 2,784,800 | 3,084,000 | 703,019 |
| 1944 | 33,579 | 895.00 | 57,856 | 1,005,200 | 1,567,000 | 2,091,000 | 571,903 |
| 1945 | 24,462 | 1,063.00 | 49,708 | 454,800 | 1,503,000 | 1,367,000 | 420,414 |
| 1946 | 34,899 | 730.00 | 38,229 | 390,500 | 737,000 | 971,000 | 318,495 |
| 1947 | 46,224 | 474.00 | 45,253 | 456,100 | 1,308,500 | 1,713,200 | 549,046 |
| 1948 | 51,734 | 694.00 | 32,059 | 621,400 | 891,100 | 1,344,700 | 526,501 |
| Total | 1,276,266 | 124,491.40 | 4,863,757 | 5,712,992 | 71,473,202 | 109,520,515 | 22,472,902 |

Zinc-lead production reached its peak in the years 1915–17, which coincided with large-scale production from the Tennessee and Golconda mines under the stimulus of high metal prices.

At the time the present investigation was being carried on in the district (early 1943), the Tennessee mine was producing and milling about 150 tons of crude ore per day averaging 7 percent zinc, 3.5 percent lead, and 17 to 25 ounces of silver per ton. A disastrous fire destroyed the Golconda mill in October 1917. Since then the Golconda has produced only intermittently and on a small scale, and the mine is now largely inaccessible on account of caving and the encroachment of water.

### FIELD WORK AND ACKNOWLEDGMENTS

Field work for the present investigation was carried on from February to June 1943. Aerial photographs on a scale of about 1 inch



equals 1,100 feet were used as base maps. The contour map on which plate 18 is based was made from the aerial photographs, after the field work was completed, by the Topographic Division of the United States Geological Survey.

It is a pleasure to acknowledge the wholehearted and able assistance rendered by Paul K. Sims, of the Geological Survey, during the field investigation. He performed a large share of the surface mapping and assisted in many other ways. Thanks are due G. E. Woodward and C. E. Needham, of the Salt Lake City office of the United States Bureau of Mines, who generously compiled much valuable statistical data on the district. Local assistance was freely given by people too numerous for specific acknowledgment. Those who were especially helpful include F. C. Cassidy, W. C. Wimer, W. J. Gardner, Frank Shuck, J. G. Blackwell, and Andrew Brown.

## GEOLOGY

### ROCK TYPES

The rocks exposed at the surface comprise pre-Cambrian crystalline rocks, chiefly of granitic composition, cut by large intrusions of Mesozoic (?) granite (the Ithaca Peak granite), especially one mass near the center of the area (pl. 18), and pre-Cambrian granite (Chloride granite) in the northern part of the area. Dikes of many rock types, probably related genetically to the Mesozoic (?) granite, are scattered throughout the area. Some are alined parallel to the prominent northwestward-trending system of fractures and veins, but others trend in different directions. Remnants of volcanic rocks of probable Tertiary and Quaternary age are found around the margins of the Cerbat Mountains but are not present in the mapped area.

Work in the area was done under the stress of war conditions; therefore it seemed inadvisable to devote much time to detailed petrographic studies of the various rock types. Also, little attempt was made to map the various types of pre-Cambrian crystalline rocks that form an intricate complex with each other and with the amphibolite and related schists and gneisses. The rock types delineated on the geologic map (pl. 18) are fairly well defined units that were selected to aid in structural interpretations or that appeared to be of sufficient size or possible genetic significance to warrant separate mapping. The units, with the exception of the dike rocks, shown on the geologic map are (1) amphibolite and related gneiss and schists; (2) undifferentiated granite, gneisses, and schists; (3) Chloride granite (new name); (4) Ithaca Peak granite (restricted name); and (5) gabbro. The first two units are considered to be of pre-Cambrian age. The Chloride granite is assigned tentatively to the pre-Cambrian, and the Ithaca Peak granite and gabbro are assigned tentatively to the Mesozoic. Three categories of dike rock are shown on the geologic map: intermediate to basic types, diabase, and rhyolite. All the dike rocks are younger than the Mesozoic (?) intrusions.

## PRE-CAMBRIAN CRYSTALLINE ROCKS

### AMPHIBOLITE AND RELATED GNEISS AND SCHISTS

One of the oldest rocks is a fine- to medium-grained dark-green to black amphibolite composed essentially of hornblende and plagioclase. In some places it appears to grade into hornblende schist, biotite schist, chlorite schist, or diorite gneiss. Locally it is epidotized, and it is very commonly cut along its schistosity by granite and granite pegmatite intrusions. The rock is particularly conspicuous in the area near Chloride; here it forms the bulk of the low hills near town and also occurs as conspicuous blocks in the granite slopes to the east. In the low hills southwest of Long Wash it is also present over a large area. It is widely distributed throughout the district, although in many places it is found in masses too small to be shown on the geologic map.

### UNDIFFERENTIATED GRANITE, GNEISSES, AND SCHISTS

The rocks in this group are represented by many types which are not separated on the geologic map. However, this group has certain outstanding characteristics, the most important of which is that most of the exposed rocks are granite. Gneissic structure is widespread, and a large percentage of the rock is granite gneiss. Some of the rocks are distinct and separate intrusions, but others are probably differentiation facies of these intrusions. Still others may represent metamorphosed sedimentary beds.

The granite in this group of rocks varies considerably in color, texture, and mineral composition, although there are certain characteristics that are common to most outcrops. The variations, some of which are extreme, are widespread but generally of small areal extent. The rock is most commonly light-gray, medium-grained, gneissoid granite, containing a small amount of mafic minerals, chiefly biotite. It commonly weathers light buff, although in a few places weathered surfaces are reddish brown.

The extreme variation in color of the fresh granite is from white to almost black. The lighter shades are characteristic of the many irregular bodies of pegmatitic granite and alaskite, generally small, which contain little or no mafic minerals. Alaskite is particularly abu[illegible]dant in the hills about 1 mile northwest of Cerbat Wash. Dark, bi[illegible]ich granites are most abundant in an irregular zone on the n[illegible] side of the main mineralized belt.

Grain size is likewise variable. Fine-grained rocks, although less common than the medium-grained ones, are nevertheless much more abundant than coarse-grained types. Coarse-grained texture is generally confined to pegmatitic granite, alaskite, or biotite-rich granite, although the latter two may also show fine- to medium-grained textures. Porphyritic texture is not common, but a few facies show enough feldspar phenocrysts to class the rock as porphyritic granite. These bodies are generally of small areal extent and are more commonly found in the biotite-rich granite than in the other types.



Variations from the usual gneissoid structure in the granite are widespread. Some facies show little or no banding or mineral orientation, whereas others show pronounced banding and are more properly classed as granite gneiss. The gneissoid structure in most of the granite is indicated by streaks or thin bands of biotite 0.1 inch or less thick.

Several distinct types of gneisses and schists are irregularly distributed throughout the pre-Cambrian complex. The most common type of metamorphic rock is granite gneiss, which varies from place to place but most commonly consists of biotite-rich lenticles and bands 0.5 to 1 inch thick alternating with lighter, irregular lenticles and bands of mixed quartz and feldspar. Some of the gneiss is highly garnetiferous, particularly in the southwestern part of the mapped area, roughly centering around the junction of Charcoal and Cerbat Canyons. Typical injection gneiss, formed usually by injection of granite or granite pegmatite into biotite schist or hornblende schist, is commonly and widely distributed.

Diorite gneiss, hornblende schist, biotite schist, and chlorite schist are sparsely distributed throughout the area, usually in small bodies associated with, and grading into, amphibolite. For this reason most of these rocks were mapped with the amphibolite, but locally they are included with the undifferentiated granite and gneisses of pre-Cambrian age. Probably most, if not all, of these rocks are genetically related to the amphibolite.

### PRE-CAMBRIAN(?) IGNEOUS ROCKS: CHLORIDE GRANITE

Schrader (1909, p. 53) has stated that the main part of the large mass of granite exposed north and northwest of Chloride much resembles the granite porphyry of the Mineral Park batholith, the Ithaca Peak granite of this report. Thomas (1949, p. 667), who likewise considered the granite near Chloride similar to the granite stock of Mineral Park, proposed the term "Ithaca Peak porphyry" for these two intrusives and tentatively assigned them to the Tertiary. The two granites, however, are quite different in their general appearance, alteration, and composition. The granite near Chloride is not nearly so altered as the granite in the Mineral Park district, and its prominent gneissic structure suggests that it may be older.

Because of this difference the name "Ithaca Peak" is here restricted to the granitic intrusive in the Mineral Park district, and the granite near Chloride, which is tentatively assigned to the pre-Cambrian, is here named the "Chloride granite."

The Chloride granite, which is well exposed north and northwest of Chloride (pl. 18), has intruded the amphibolite and older granite gneisses, forming a central band at the northeast end of a large fold in the pre-Cambrian crystalline rocks. Except near its borders, the intrusive body is fairly uniform, although it contains numerous inclusions of the older rocks. Some small, irregular masses and dikelike bodies extend beyond the limits shown on the geologic map. No attempt was made to map these smaller units. The Chloride granite weathers yellowish brown. Locally the rock breaks down easily and forms rounded hills, but most of it stands out as large blocky masses that are prominently jointed.

The rock is typically a light-gray, medium-grained, gneissoid granite. The gneissic structure, which in general conforms to the schistosity of the older folded rocks, in many places grades into a schist as the borders of the older rocks are approached. Microscopic examination discloses microcline, quartz, and biotite as the dominant minerals. The quartz is largely recrystallized. Biotite is the green variety, greatly frayed, fragmentary, and drawn out into bands. Accessory minerals are magnetite, apatite, and zircon. Locally the granite shows considerable variation in texture, ranging from fine to moderately coarse, and some facies are lacking in the typical gneissic structure. Near the border of the intrusion is a garnetiferous, light-gray or dull-white granite.

## MESOZOIC (?) IGNEOUS ROCKS

### ITHACA PEAK GRANITE

The name "Ithaca Peak" as used by Thomas is restricted by this writer to the granite of the Mineral Park district. The granite stock, near the center of the Mineral Park district, has intruded the pre-Cambrian granite, gneisses, and schists (pl. 18). Pegmatite, aplite, rhyolite, and many, if not all, of the diabase and intermediate- to basic-type dikes, as well as the veins in the district, are believed to be genetically related to this intrusion.

The main mass of the granite stock near Mineral Park weathers buff to reddish brown and generally forms a distinctive color contrast to most of the older rocks in this area, which weather to much lighter shades of buff and brown. Both Ithaca Peak and Turquoise Mountain are composed of the Ithaca Peak granite.

Unaltered specimens of the Ithaca Peak granite are rare. Those found show that the fresh rock is typically a light-gray, fine- to medium-grained, porphyritic granite. Microscopic examination of thin sections of the fresh rock shows that the phenocrysts are chiefly subhedrons of pink orthoclase commonly ranging from 2 to 5 millimeters in length. Phenocrystic quartz is much less abundant than the orthoclase and occurs as irregular grains commonly ranging from 0.15 to 0.25 millimeter in length. The groundmass consists chiefly of quartz and orthoclase. Biotite and rarely hornblende are the principal mafic minerals, and together they seldom constitute more than 7 percent of the rock. Other minerals found in small quantities include microcline, microperthite, oligoclase, sphene, magnetite, apatite, zircon, sericite, chlorite, and a clay mineral, probably kaolin.



Most of the rock of the stock contains only a few percent of phenocrysts and for that reason is classed as porphyritic granite. Locally, however, fine-grained facies contain abundant phenocrysts, and the rock is typical granite porphyry. Other differentiation facies are coarse-grained granite and granite pegmatite.

In many places it was difficult or impossible to locate the contact of this intrusive with the pre-Cambrian granites because of the alteration of the intrusive and the surrounding rocks, combined with the similarity of some of the differentiation facies of both the older and the younger granites.

Outlying bodies of the Ithaca Peak granite are particularly abundant from Mineral Park south into Stockton and Cerbat camps (pl. 18). Some extend beyond the southern border of the area mapped. They occur as dikes or, more commonly, as irregular elongated intrusive masses of diverse sizes, many too small to be shown on the geologic map. A few of the intrusives occur irregularly alined along northwestward-trending fissures. Some appear, in part at least, to have been intruded along the older schistosity planes. Dips of the outlying bodies are generally steep, the lowest recorded being 57° on the wide northeastward-trending dike a few miles southeast of Mineral Park. The direction of dip varies, but dips to the northeast, north, and northwest are the most numerous.

These outlying granite bodies are somewhat different from the main intrusive body exposed near Mineral Park. The rock is of finer grain size, and porphyritic texture is more common. Some of the rock grades into granite porphyry, although most of it is porphyritic granite. Badly altered feldspar phenocrysts are characteristic, and only rarely are parts of the rock found that are not intensely altered. The outlying granite bodies stand out in bold relief, particularly in the area near the Golconda mine and in the vicinity of Stockton. The bodies very commonly are intensely sheared, fractured, and silicified. The rock has weathered to brownish red, dark brown, or black, probably from alteration of finely disseminated pyrite.

In the northern part of the district a few narrow dikes and elongated bodies of granite, generally too small to be shown on the geologic map, are poorly exposed for short distances. Some may be genetically related to the Ithaca Peak granite, but no certainty exists as to this correlation.

The age of the intrusion is not known except that it is younger than the pre-Cambrian complex and older than the volcanic rocks of Tertiary (?) age. Schrader (1909, p. 30) states that it is very likely of late Jurassic or early Cretaceous age and of the same period of intrusion as the batholiths of California and western Nevada. Thomas (1949, p. 667) believes that his Ithaca Peak porphyry is of Tertiary (?) age on the "basis of close areal and structural relationships between the Mineral Park stock and the mineralization." However, on a later page (1949, p. 695) he makes the statement that "a direct genetic connection between the Ithaca Peak porphyry and these ore deposits does not seem reasonable, * * * owing to the time interval that elapsed between intrusion and mineralization." It is quite possible that the intrusion may be Tertiary in age, but the only direct evidence Thomas obtained is that the intrusion cuts rocks of pre-Cambrian age. Since no positive evidence is available in the Wallapai district to aid in dating the intrusion, it is still considered tentatively in this report as Mesozoic in age.

#### GABBRO

In the southern part of the mapped area, centering around Cerbat, are numerous small stocks and irregular bodies of gabbro (pl. 18). The largest of these, located 0.6 mile northeast of Cerbat, is about 1,500 feet in its longest dimension. Gently dipping gabbro or diabase sills are scattered throughout the district from the locality north of Chloride to the southern part of the mapped area. Many of these are too thin or discontinuous to be shown on the geologic map. The thickest and best-exposed sill is on the steep west slope of the Cerbat Mountains about 2 miles east of Chloride near the Redemption mine. The sill reaches a maximum thickness of about 60 feet north of the mine.

The gabbro is typically a greenish-black, medium-grained rock commonly having a pronounced diabasic texture. Chilled border facies and small dikes stemming from the larger gabbroic masses are typical diabase. Weathered surfaces are usually reddish to dark brown. Microscopic examination of thin sections shows that the dominant minerals are labradorite, olivine, augite, and hypersthene. The olivine has been slightly serpentinized. Other minerals present include biotite, a very small amount of green hornblende, apatite in long needles, magnetite, and calcite.



The diabase sills, as well as the diabase dikes to be described later, are all believed to be related to the smaller gabbro intrusives. Hernon (1938, p. 113) states that the diabase of the Cerbat Mountains closely resembles the diabase sills in the Grand Canyon series and in the Apache group of southeastern Arizona, which are regarded as pre-Cambrian in age. The exact age of the diabase in the Wallapai district is not known. The gabbro cuts the pre-Cambrian granites, gneisses, and schists but in turn is cut by mineralized quartz veins and rhyolite dikes.

#### DIKE ROCKS

Dikes of many lithologic types cut the rocks of the Wallapai district. They range in thickness from a few inches to 300 feet. Some extend only a few hundred feet or less, whereas others, notably the rhyolite dikes, extend for long distances. The most abundant dike rocks are granite pegmatites. Others, some of which are abundant locally, include porphyritic granite, aplite, and rhyolite. Also, there is a group of dikes of intermediate to basic composition, including such rock types as vogesite, minette, kersantite, camptonite, andesite, and diabase.

Only dikes that are 1 foot or more thick and appear to be fairly continuous are shown on the geologic map. Granite pegmatite dikes, although abundant, were not mapped because an excessive amount of time would have been required to outline these generally narrow and discontinuous bodies. Aplite dikes are not common and generally occur as short, very narrow bodies; hence they also are not delineated.

The age relationships between the various types of dike rocks are rarely indicated in the field. Many of the dikes, particularly some of the intermediate to basic types, are found only in the pre-Cambrian rocks far removed from outcrops of the Ithaca Peak granite. It is possible that some of these are older than that granite. Nevertheless, all the dikes shown on the geologic map are assigned an age younger than the Mesozoic (?) intrusives because of their lithologic similarities to other dikes definitely younger than these intrusives. All the dikes shown on the geologic map are likewise believed to be genetically related to the Ithaca Peak granite, even though some, particularly the rhyolites, may represent considerably younger intrusions.

*Granite, porphyritic granite, and granite porphyry.*—Dikes and somewhat irregularly shaped, elongated bodies of fine- to medium-grained, rarely aphanitic or coarse-grained granite occur at many places in the southern part of the mapped area. They are most commonly alined parallel to, or fill, the northwestward-trending fractures. These bodies are related to, and in places are definitely part of, the intrusive at Mineral Park, the Ithaca Peak granite, and are shown as part of this mass on the geologic map. Many of them change along their trends from typical tabular dikes to irregularly shaped, elongated intrusions or to irregular bodies. The typical dikes commonly range in thickness from 50 to 250 feet.

The rocks show many gradations in texture, commonly within short distances. Most of the rock is porphyritic granite, although some is granite, and only rarely is the grain size so small that the rock should be classed as granite porphyry. Orthoclase phenocrysts are much more common than quartz.

*Granite pegmatite and aplite.*—Most of the granite pegmatite dikes are less than 2 feet thick and seldom can be traced for more than a few hundred feet. Many appear to stem from highly irregular bodies of pegmatite a few hundred feet or less in longest dimension. The pegmatites are composed almost entirely of quartz and feldspar, though rarely other minerals, chiefly muscovite, may be present. They probably are genetically related to the Ithaca Peak granite.

Granite aplites, though widely distributed, are not abundant. They generally occur as narrow dikes ranging from a few inches to a foot in thickness. They are fine-grained, equigranular rocks consisting largely of quartz and feldspar.

*Andesite, minette, vogesite, diabase, kersantite, and camptonite.*—Andesite, minette, vogesite, and diabase are the most common rock types in the dikes of intermediate to basic composition, although some more nearly approach kersantite or camptonite. On the geologic map (pl. 18) the diabase dikes are shown distinct from the other dikes of intermediate to basic composition.

Alteration of these dikes commonly results in a greenish or brownish earthy appearance, but when fresh they are grayish to dark green. Porphyritic textures predominate. Partly because of their basic character these dikes weather easily and are poorly exposed, but they also seem to occur as less continuous bodies than the other dikes, particularly those consisting of rhyolite. On the geologic map (pl. 18), only the more continuous dikes of intermediate to basic composition are shown; there are many more that are too short to map.

Many of these dikes cut the pre-Cambrian rocks. They range from a few inches to 10 or more feet in thickness, but they average about 2 feet. In a few places they fill the vein fractures, but they seldom extend continuously along the veins for more than a few hundred feet. In every case where definite age relations could be obtained, the dikes are older than the veins.

*Rhyolite.*—Extending irregularly northward across much of the district is a network of rhyolite dikes (pl. 18), all believed to be of the same general age. The dikes are most abundant in a fairly obvious belt about 4 miles long that extends from a short distance south of Cerbat north to the southern edge of the main body of the stock at



Mineral Park. Rhyolite dikes are extremely rare, however, in the area northwest of the northern part of the Great White dike.

Many of these dikes trend northwest roughly parallel to the prominent vein system. The dips are generally steep, but some are as low as 50°; strike and dip commonly change within comparatively short distances. In places the rhyolite dikes cut, border, or trend parallel to the elongated bodies and dikes of the Ithaca Peak granite, a characteristic that is particularly conspicuous in the area north and northwest of the Oro Plata mine. Many of the dikes have numerous branches, some of which are too small to be indicated on the geologic map. The rock is characteristically white to light buff, aphanitic with occasional quartz phenocrysts, and in general greatly fractured.

The largest rhyolite dike, the one known locally as the "Great White dike," cuts the western part of the main mass of Ithaca Peak granite. It can be traced with little difficulty throughout most of the district, for a distance of about 6 miles, and it continues for an unknown distance to the northeast beyond the limits of the mapped area. This dike ranges in thickness from a few feet to as much as 100 feet but generally averages about 30 feet. In places it forms sharp ridges as much as 35 feet high, but more commonly it shows as a band of chalky white debris cutting irregularly across the other rocks. Schrader (1909, p. 92) states that this dike is an altered basic rock. However, microscopic examination of thin sections of the rock indicates a rhyolitic composition.

About 2 miles north of Cerbat, near the Oro Plata mine, is a prominent branch of the Great White dike that trends N. 10° E. and is locally known as the "Broncho dike." It can be readily traced to the northeast for a distance of 2 miles. It dips about 60° NW. and traverses or borders a wide dike of porphyritic granite related to the main Ithaca Peak granite. Hernon (1938, p. 113) states that the Broncho dike may be genetically related to the volcanic rocks of Tertiary (?) age in adjacent areas which are composed principally of rhyolite flows, tuffs, and agglomerates. Reconnaissance by the author in the volcanic area near Kingman failed to disclose any of the rhyolite dikes cutting or stemming from the volcanic beds.

All the rhyolite dikes in the Wallapai district, including the Great White dike and the Broncho dike, are believed by the author to be genetically related to the intrusion of the Ithaca Peak granite of Mesozoic (?) age. They cut this granite and its associated dikes but in turn are cut in a few places by mineralized veins that are believed to represent the last stage of the intrusion at Mineral Park. Thomas (1949, p. 668), however, assumes that the rhyolite dikes in the Wallapai district "were intruded in Tertiary times as part of the Tertiary volcanic system of the Basin and Range Province." His assignment of a probable Tertiary age to the Ithaca Peak granite, as opposed to a Mesozoic (?) age for this granite in the present report, would account for Thomas' assumption, as the dikes cut the stock at Mineral Park.

## STRUCTURE

The Cerbat Mountains are in the Basin and Range geomorphic province only 20 miles west of the edge of the Colorado Plateau. The major geologic setting is shown on the geologic map by Schrader (1909, pl. 1), which is not duplicated in this report.

The structure of the rocks in the Wallapai district is complex. Gneissic and schistose structures are common, the prevailing schistosity striking northeast. Large and small folds in the schistosity generally have axes that strike northeast. In contrast faults, sheeting, and joints most commonly show a northwesterly strike.

### SCHISTOSITY

The gneissic and schistose structure of the pre-Cambrian rocks in the Wallapai district strikes in general from N. 40° E. to N. 65° E. and dips steeply either to the northwest or to the southeast. Local variations are numerous, but the structure is unusually persistent throughout most of the district, and reconnaissance visits to a few other parts of the Cerbat Mountains disclosed essentially the same general structure.

### FOLDS

Folds in the pre-Cambrian rocks occur on both a large and a small scale. The most prominent of these folds is near the town of Chloride (pl. 18), where the type of fold is reflected in the outcrop of pattern of the amphibolite. It is a large anticlinal fold, plunging northeast, only the northeast end of which is shown on the geologic map. To the southwest, beyond the limits of the mapped area, the fold is exposed for about a mile before it is concealed under the debris in Sacramento Valley. Much more of this fold is clearly shown on Thomas' geologic map (1949, p. 669, fig. 2), which covers an area extending about 3 miles west of the area mapped for this report. His map shows that the fold is several miles wide where it disappears under the alluvium of Sacramento Valley. North and northwest of Chloride a granite intrusive (Chloride granite) occupies a sill-like belt in the folded amphibolite.

### FAULTS

The most outstanding structural feature of the district is the northwestward-trending fault fissures along which veins have formed (pl. 18). A few faults, generally of small displacement, crosscut and offset these mineralized faults. A large normal fault (Sacramento fault), which strikes northwest, is probably concealed under the alluvium of Sacramento Valley near, or west of, the border of the mapped area.



#### NORTHWEST FAULT FISSURES

From the southern end of the district northwest to the folded area near Chloride the fault fissures are very generally parallel in strike, the direction of strike being approximately at right angles to the regional schistosity. In the folded area near Chloride, however, the fissures conform to the general direction of schistosity. Here they change first to a more northerly strike, then follow the curvature in the strike of the rocks to the north and west around the axis of the fold so that in the extreme northwestern part of the mapped area the fissures strike nearly due west.

The dips of the faults are generally steep and may be either to the northeast or to the southwest, although northeasterly dips predominate. In places the faults are in conjugate systems. The fissures likewise show much branching and, in a few places, considerable "horse-tailing." Gouge, breccia, and slickensided surfaces, as well as numerous tear faults in the walls, are present along some of the faults. The direction of the striations along the walls of the faults may be nearly horizontal, but a far greater number show dips down or diagonally down the dip of the fault surface. Most of these features suggest that shearing stress was important.

The age of the faulting that produced the northwest fault fissures is not known. The initial, and probably most intense, movement occurred after the gneissic and schistose foliation was developed in the pre-Cambrian complex and prior to the Mesozoic (?) intrusions. This is indicated by the fact that the faults cut the old (probably pre-Cambrian) gneissic and schistose structures and in turn are filled, or partly filled, in many places by the Mesozoic (?) dikes and veins. Brecciation of the veins and dikes in places indicates that some movement occurred at intervals throughout, and following, ore deposition. These later periods of movement, however, are believed by the author to have been very minor compared to the tectonic forces that formed the main northwestward-trending faults. It is likely that the major tectonic forces were active early in the Nevadian orogeny and that the minor period of movement occurred near the close of this orogeny.

#### TRANSVERSE FAULTS

Some faulting, believed to be still later than the brecciation of the veins and dikes that occupy the northwest fault fissures, occurred in a few places throughout the district. There is no evidence to indicate that this faulting was of major structural importance, for it most commonly is expressed by small crosscutting faults offsetting the dikes and veins a few feet or less. Several crosscutting faults, however, have greater displacements. One mile north of Mineral Park, about 1,400 feet northeast of the Eureka mine, a northwestward-trending fault has offset the Great White dike about 140 feet. About a mile east of Chloride is a northeastward-trending fault that is shown on the geologic map. The Payroll vein has apparently been offset about 600 feet by this fault, the South Georgia mine supposedly being on the offset part of the Payroll vein. This fault, however, may predate mineralization, according to data obtained on the inaccessible workings in the Payroll mine. Dr. J. G. Blackwell, of Chloride, stated in April 1943 that the Payroll vein turns abruptly to the southwest and follows the fault. He added that the vein is thick and shows no evidence of brecciation of the ore minerals along the fault.

#### SACRAMENTO FAULT

The large normal fault previously referred to as lying concealed beneath the alluvium in Sacramento Valley is based upon Thomas' mapping (1949, fig. 2) several miles west of Chloride and beyond the area mapped for this report. This fault has been aptly termed the "Sacramento fault." It strikes northwest and brings volcanic rocks of assumed Tertiary age on the southwest side in fault contact with rocks of pre-Cambrian age on the northeast side. The fault was traced by Thomas southeast to a point about 2½ miles west of Chloride; beyond this point he projects it southeastward under the alluvium for almost 4 miles to a point near the border of his mapped area. This fault is not shown on the geologic map (pl. 18) accompanying the present report, because its location under the alluvium is entirely too uncertain.

In discussing the Sacramento fault Thomas (1949, p. 671) states that it seems to be a boundary fault between Sacramento Valley and the Cerbat Range and that "vertical displacement on this fault and perhaps on allied faults that might be buried under an alluvial cover is believed to be responsible for the formation of the Cerbat Range, which is essentially an eastward-tilted block."

#### JOINTS

Jointing is pronounced throughout most of the district. In places it grades into sheeted and sheared zones, both generally of small areal extent. Commonly one of the joint systems is far better developed than the others, and on the geologic map accompanying this report only the attitudes of the most prominent joint systems are shown. The strike commonly ranges from N. 30° W. to N. 60° W., approximately parallel to the mineralized fissures. Dips are generally moderate to steep and may be either to the northeast or to the southwest. In a few places low-dipping fractures are fairly well developed, but they are not common. In general they have the same northwesterly strike as the other fractures and dip either to the northeast or to the southwest.



## ORE DEPOSITS

### TYPES OF DEPOSIT

The ore deposits are conveniently separated into three types. The first is represented by the vein deposits of the district, the second by a quartz-sulfide stockwork deposit, and the third by the Emerald Isle copper deposit. The vein deposits are overwhelmingly the most important in the district. The quartz-sulfide stockwork deposit contains some low-grade copper and molybdenum. The Emerald Isle copper deposit is quite different from all other deposits in the district and consists of a fissure vein and mineralized area of chrysocolla chiefly confined to alluvium.

### VEIN DEPOSITS

#### GENERAL FEATURES AND DISTRIBUTION

The chief ore deposits of the Wallapai district occur in veins along fissures in all the rock types previously described. In some places the veins are along dikes of intermediate to basic composition, but they seldom extend continuously along these dikes for more than a few hundred feet. Other veins border or cut the rhyolite dikes, but generally such veins are poorly mineralized and of erratic extent and width. The most notable exception is the Eureka vein north of Mineral Park, where the mineralization was fairly rich. Wherever definite age relations could be observed, the veins are younger than the dikes. The source of the vein-forming solutions is believed to have been the magmatic reservoir of the granite stock (Ithaca Peak granite) centrally exposed about 1 mile south of Mineral Park (pl. 18). The veins in the district are classed as mesothermal deposits.

The veins range from a few inches to 33 feet in thickness but average 3 to 4 feet. In a few places the deposits are in lodes or vein zones, which rarely exceed a width of 50 feet. Most of the Silver Hill vein is of this type. Schrader (1909, p. 62) states that in the older workings of the Payroll mine a lode 100 feet wide was encountered. Vein widths reported in many of the mines are often exaggerated, as they frequently include considerable unmineralized wall rock between vein branches.

The veins show a strike length that varies from a hundred feet or less to almost 2 miles, but only the Victory, Tennessee, Clyde, Payroll, Emerson, Dutch Joe, South Washington, Rico, White Eagle, Banner, Summit, and Manzanita veins exceed a length of 1 mile. The aggregate length of the veins in the district as measured from plate 18 is about 85 miles. The veins commonly pinch and swell along both strike and dip. Numerous irregular branches, short spur veins, narrow parallel veins, and hydrothermally altered fissures are characteristic. About 2 miles southeast of Chloride, in the vicinity of the Twentieth Century and Midnight mines, the veins are unusually irregular and branching. This is the area in which the northwestward-trending veins deviate to a more northerly course.

### VEIN DIPS AND TRENDS

Dips are commonly steep, only occasionally being less than 60°. Some veins show a moderate amount of reversal in dip as they are traced along strike or down dip. The dips shown on the geologic map (pl. 18) are, almost all of them, those obtained near the surface in shafts or prospect pits. In places the vein systems are conjugate, as noted by Schrader (1909, p. 50), but the conjugate arrangement is not nearly as common as suggested by its mention in brief descriptions of the district. Garrett (1938, p. 118) states that the progressive steepening of the dip of the veins to the northwest may indicate overthrusting stresses as the cause of the fissuring. However, detailed mapping does not support this conjecture.

Reference to plate 18 will show the prevailing northwesterly trend of the veins. Throughout the greater part of the district strikes range from N. 30° W. to N. 60° W. Near Chloride the average strike changes to a few degrees west of north, and still farther north and west a few veins trend nearly west. Throughout the main mineralized area southeast of Chloride the sparsity of eastward- or northeastward-trending veins is notable.

Plate 18 shows clearly that the veins occur in two main groups, one north and the other south of the main body of the stock of the Ithaca Peak granite. The total length of the mapped veins in each group is about equal. Veins of the northern group have more branches than those in the southern group. Likewise a statistical study of the direction of dip of the veins in the two groups shows differences. In both groups the total mapped lengths were measured separately for veins dipping to the northeast, to the southwest, and vertically, and the percentages of each were calculated. The results are as follows: northern group, 57 percent northeasterly dip, 25 percent southwesterly dip, and 18 percent vertical dip; southern group, 88 percent northeasterly dip, 11 percent southwesterly dip, and 1 percent vertical dip. In the northern group it is further notable that southwestward-dipping veins are almost entirely absent in the folded area north of Chloride.

### RELATION OF VEINS TO COUNTRY ROCK

Some veins are separated from the wall rock by soft gouge bands a fraction of an inch to several feet in thickness. Gouge may be present on the hanging wall, on the footwall, on both walls, or irregularly traversing the veins. Many veins, however, are frozen to the walls. The type of wall rock has had little effect upon the character of the veins. In a few places, particularly near Chloride, some veins tend to split into branches as they pass laterally into large amphibolite blocks, but a short distance inside the block the veins generally assume their usual characteristics.



### APPEARANCE AT OUTCROP

A few veins, notably the Payroll, Cerbat, and Manzanita, crop out over part of their lengths as prominent iron-stained quartz "ridges," but moderate to very careful observation is generally required to follow them. In tracing the veins on the surface by far the greatest aid is the many man-made excavations such as shafts, trenches, pits, and short adits. These are so numerous and in many areas so closely spaced that not all of them are shown on the geologic map (pl. 18). Probably there are at least a thousand prospects in the district. It is largely upon the data obtained from these workings that most of the veins are shown on the geologic map as solid, instead of broken, lines.

Vein outcrops commonly appear as brown, porous gossan or as pink to dark reddish-brown bodies composed chiefly of iron-stained quartz. Variations in depth of oxidation are so numerous that generalizations are difficult. The upper parts of the veins have been moderately oxidized to depths commonly ranging from about 75 to 200 feet. In some places unaltered pyrite is found within a few feet of the surface, yet Dr. J. G. Blackwell, of Chloride, stated in May 1943 that partially oxidized ore was found as deep as the 600-foot level of the Payroll mine. Complete oxidation seldom extends lower than 75 feet below the surface.

The depth to water level, although commonly 35 to 200 feet, ranges from 20 to 400 feet. In general this range coincides fairly well with the depth of the oxidized zone.

### MINERALS

The vein minerals of the district fall into three general groups: oxidation products, products of downward sulfide enrichment, and primary (hypogene) minerals. In recent years, the primary ores have been the most worked for their base metals, but in the early years of mining in the district most attention was paid to the oxidized ores because of their precious-metal content.

The principal minerals of economic importance in the oxidized zone are cerargyrite, native silver, cerussite, and to a less extent native gold. Locally anglesite, azurite, malachite, mimetite, and vanadinite are common. Other minerals which are rare or occur as coatings include native copper, chalcanthite, covellite, cuprite, smithsonite, and manganese oxides. The most common gangue minerals are limonite and limonitic quartz. Calcite and particularly gypsum are rare.

The secondary sulfide enrichment products as determined by Bastin (1924, p. 35) are argentite, chalcocite, covellite, and proustite. He states that all except argentite are rare. Secondary enrichment in the vein deposits of the Wallapai district has not been important.

Excluding gangue minerals, the most abundant of the primary minerals are pyrite, sphalerite, galena, and chalcopyrite. Other minerals include arsenopyrite, proustite, molybdenite, and argentite. In addition to those listed Bastin has recognized tennantite, pearceite, and polybasite. Gangue minerals are quartz, calcite, manganiferous siderite, and rarely rhodochrosite.

Quartz, usually accompanied by varying amounts of pyrite, is by far the most abundant gangue mineral. Most of the quartz is fine-grained and milky to gray in color. Some is of the chalcedonic variety. In many places along the veins small vugs are lined with quartz crystals. In a few places the veins show a poorly defined comb structure, but the quartz is generally massive and commonly fractured and recemented by later quartz.

Sphalerite ranges in color from brown through reddish brown to black. It occurs most commonly in irregular masses or grains intimately associated with quartz and the other sulfides. The grain size varies greatly, but generally sizes of less than 0.3 inch predominate. The sphalerite also occurs as narrow bands or streaks. J. W. Sharpe, metallurgist for the Tennessee-Schuylkill Corp., stated in June 1943 that careful analyses of specimens of sphalerite collected in the Tennessee mine indicated the presence of a considerable amount of gold as well as minor amounts of silver. Sphalerite has been leached from the completely oxidized parts of the veins.

Galena occurs in fine to coarse grains; some is the very fine grained steel type, and some, commonly in the same ore shoot, is in cleavable masses as much as 3 inches in length. Practically all the galena, regardless of type, is silver bearing, and much of it is high in grade. J. W. Sharpe stated in June 1943 that the galena from the Tennessee mine contained most of the gold values produced in the mine. He believes that the pyrite in the Tennessee mine is practically, if not entirely, barren of gold. This is in contrast to Garrett's statement (1938, p. 119) that gold in this mine is obtained from pyrite. Additional analyses from the mine, and also for the district, would be needed to clarify these contradictory statements.

In many places unaltered galena is found at or near the surface; elsewhere it has altered to cerussite.



## PARAGENESIS

The paragenesis of the principal hypogene minerals, as determined megascopically, is quartz, pyrite, arsenopyrite, sphalerite, galena, and chalcopyrite. Much of the ore shows a second generation of pyrite following galena. Quartz was introduced intermittently throughout the period of mineralization. A few veins show late calcite, manganiferous siderite, and—rarely—rhodochrosite.

Observations during this investigation coincide in general with Hernon's statements (1938, p. 115) regarding the main stages of mineralization. Fissures, some of them locally occupied by earlier dikes, were reopened; in the openings solutions deposited quartz, usually accompanied by pyrite. Many of the vein fissures were closed by this early stage of mineral deposition. Subsequent reopening permitted solutions to bring in the valuable constituents of the veins. A still later but minor reopening followed; in the voids thus formed quartz was deposited as narrow veinlets commonly cutting the earlier sulfides. A final movement produced gouge and quartz breccias, but the mineralization is believed to have ceased largely thoughn not entirely before this stage. The structure of the veins is irregularly massive or crudely banded by the arrangement of the sulfides.

## ORE SHOOTS

The typical ore shoots in the unoxidized zone are complex assemblages of galena, sphalerite, and pyrite in quartz gangue. Chalcopyrite and arsenopyrite are not nearly as abundant, but a few of the mines, such as the Pinkham, Midnight, and Keystone, recovered a moderate amount of copper along with the other metals. Much of the vein matter is very low in grade. Narrow stringers and small irregular masses of the valuable minerals may persist throughout almost the entire length of the vein, but they are too small to be commercially valuable unless the gold or silver content is exceptionally high. However, few completely barren quartz veins occur in the district, and those which exist are short. Likewise, most of the veins have not been explored to sufficient depths to warrant condemnation based on the low base-metal content near the surface.

Ore shoots are generally small and as a rule range from 8 or 10 inches to 3 or 4 feet in thickness. The thickest shoot found measured 20 feet (Tennessee mine). Both the pitch lengths and the breadths of the shoots commonly measure about 10 to 50 feet. In the Tennessee mine (pl. 19) one ore shoot extends 400 feet horizontally and 700 feet vertically. An ore shoot in the Golconda mine is reported to have greatly exceeded in size any in the Tennessee, but the Golconda was not accessible for examination. The Tennessee and Golconda mines probably represent extreme cases, although the comparatively shallow depth reached in most of the other mines does not permit too broad a generalization. Commercial ore has been reported from the Tennessee and Golconda mines to depths of about 1,600 feet.

The character of the wall rock has had no apparent effect upon the localization of the ore bodies. Garrett (1938, p. 118) states that in the Tennessee mine ore shoots tend to occur where the vein has changed to a more westerly strike than normal. Later work in the mine supports this generalization. Schrader (1909, p. 51) states that many of the ore shoots coincide with intersections or forkings of the veins. Distinct vein intersections, however, are rare. Many of the forks are enriched, but many of them have lower-grade ore than average.

### QUARTZ-SULFIDE STOCKWORK DEPOSIT

Centering around the main stock at Mineral Park is an area embracing several square miles of altered and fractured rock that contains many short and irregular sulfide-bearing quartz seams and veinlets that are distinct from the fissure veins found elsewhere. Mineralization of this type is chiefly confined within the Ithaca Peak granite but locally extends about 2,000 feet beyond into the older granites, gneisses, and schists. It is a poorly defined area with gradational and irregular borders and likewise much irregularity of mineralization within the main granite mass. Mineralization also extends into part of the large tongue of Ithaca Peak granite extending southeastward from the main stock to the Oro Plata mine. Most of the rhyolite dikes that cut the main stock are fractured and mineralized.

The veinlets occur most abundantly in highly fractured rock and form an intricate network generally with no persistent strike or dip. They are closely spaced and are rarely more than 6 inches apart. Thicknesses most commonly range from one-twentieth to one-half inch, although some veinlets are very thin seams and others reach a thickness of several inches.

The primary minerals are quartz, pyrite, chalcopyrite, bornite, molybdenite, galena, and sphalerite. Quartz and pyrite are by far the most abundant, and the amount of quartz greatly exceeds that of pyrite. Most of the quartz and sulfide minerals fill fractures, and only rarely are the sulfides disseminated in unbroken rock. For this reason the deposits are classed as a stockwork rather than as a disseminated deposit.

Locally chalcopyrite and molybdenite are associated with the quartz-pyrite veinlets as low-grade deposits. Rarely chalcopyrite occurs disseminated in small grains in the granite. Many veinlets of quartz and pyrite cut veinlets of quartz, pyrite, and molybdenite, although this relation was reversed in one specimen examined from



the Gross molybdenite prospects. In general, however, most of the molybdenite formed at an early stage.

Small veinlets of galena, sphalerite, and pyrite in quartz gangue occur in a few places, notably on the northwest side of Ithaca Peak. No definite paragenetic relations could be established between these and the more common quartz-pyrite-chalcopyrite (or molybdenite) veinlets. The mode of occurrence and the intimate association of the two types suggest a close relationship, and both are probably of the same general period of mineralization as the prominent fissure veins of the district.

Much of the mineralized area, particularly around Ithaca Peak, has been so thoroughly silicified that the rocks have eroded into very rough forms. Hydrothermal alteration has produced abundant sericite, and much of the rock in the highly altered areas seems, in hand specimens, to consist almost entirely of sericite and quartz.

Oxidation and secondary enrichment have been widespread. Hydrous iron oxides are abundant on the higher peaks and also form the principal cementing material for some alluvial conglomerates. In Bismark Canyon, about half a mile east of the Gross ranch, is an alluvial conglomerate consisting of pebbles and cobbles cemented by hydrous iron oxides, cuprite, and malachite. Chalcanthite, azurite, malachite, covellite, native copper, and chalcocite are fairly widespread although generally not abundant. The Gross copper prospects are reported to have encountered considerable chalcocite and native copper.

### EMERALD ISLE COPPER DEPOSIT

The Emerald Isle mine, located about a mile west of Mineral Park Wash, is the only known deposit of its type in the district. The ore mineral is chiefly chrysocolla contained in a fissure vein and filling spaces in alluvium of Quaternary age. It is described in detail under the heading "Emerald Isle mine."

## GENESIS AND AGE

The vein and stockwork deposits are believed by the author to be genetically related to the Ithaca Peak granite. The granite, dikes, and mineralizing solutions are believed to have had a common source and were merely drawn off at different times. The time interval between the dikes and the mineralizing solutions in this area may have been fairly long, for the dikes and granite were locally brecciated prior to the introduction of the mineralizing solutions. The central position of the Ithaca Peak granite and the close association of the granite, dikes, and ore deposits strongly favor a genetic relation. The major structural control for their localization was established prior to the period of granite intrusion.

The vein and stockwork deposits are assigned a Mesozoic (?) age, for they are believed to be genetically related to the Ithaca Peak granite of that age. Schrader (1909, p. 48) likewise assumes a similar age and a genetic relationship of these ore deposits to the stock at Mineral Park; furthermore, he points out that they are quite different from the veins of the nearby Black Mountains that are of Tertiary age.

The Emerald Isle copper deposit is of Quaternary age. (See pp. 149–153.)

### ZONING

The scanty information in the mine records and the exposed mine workings suggest that chalcopyrite and sphalerite increase relative to galena with depth in the mines of the district. However, exceptions are so numerous that this generalization should be very tentatively accepted. The best indication of increase in sphalerite with depth is found in the Tennessee vein (pl. 19). Here Garrett (1938, p. 118) has demonstrated an increase in sphalerite and a decrease in galena with depth from those parts of the mine for which reliable records have been kept. It should be remarked, however, that no records exist for a large part of the mine.

Indications of pronounced lateral zoning in the district are generally lacking. There is evidence, however, that copper and molybdenum are found in larger amounts in and nearer to the intrusive granite of the Mineral Park area than in the outlying parts of the district. Also, the chief values of the veins in the extreme southeastern and northwestern parts of the district were in silver, suggesting that silver was more characteristically formed at a considerable distance from the intrusive body. Garrett (1938, p. 118) notes horizontal zoning in the Tennessee vein (pl. 19), with a general increase in sphalerite and a decrease in galena and gold-bearing pyrite to the south.

### PRODUCTION OF SELECTED MINES

Table 2 gives the production of gold, silver, copper, lead, and zinc from 1901 through 1948 of the more important mines in the district, as well as that of some of the smaller operations. Mines that have been small producers during this period may, however, have had a substantial production prior to the years for which accurate records were kept, particularly the old mines in which rich silver and gold ore was obtained from the oxidized parts of the veins.

It is notable that the combined output of the Tennessee-Schuylkill and Golconda mines has accounted for more than 90 percent of the total lead and zinc produced in the district from 1904 to 1948.



TABLE 2.—*Production of gold, silver, copper, lead, and zinc of selected mines in the Wallapai district, Mohave County, Ariz., cumulative from 1901 through 1948, in terms of recovered metals*

[Compiled by Metal Economics Branch, U. S. Bureau of Mines, Salt Lake City, Utah]

| Mine | Gold (oz.) | Silver (oz.) | Copper (lbs.) | Lead (lbs.) | Zinc (lbs.) |
|---|---|---|---|---|---|
| Alpha (*m*) | 292 | 35, 499 | 22, 265 | 16, 476 | ---------- |
| Altata and Altata Extension (*c*) | 382 | 36, 024 | 136, 616 | 7, 691 | ---------- |
| Badger, Hercules, and Hercules group (*c*) | 561 | 12, 287 | 1, 418 | 331, 365 | 52, 524 |
| Banner group (*s*) | 1, 697 | 79, 382 | 21, 603 | 2, 195, 988 | 39, 948 |
| Blackfoot (*cer*) | 158 | 11, 886 | 19, 617 | 104, 565 | 144, 369 |
| Blue Bell (*s*) | 469 | 50, 954 | 44, 274 | 182, 001 | ---------- |
| Cerbat (*cer*) | 42 | 2, 055 | 1, 153 | 4, 120 | ---------- |
| Champion (*cer*) | 982 | 23, 689 | 14, 931 | 825, 993 | 335, 391 |
| C. O. D. (*s*) | 1, 550 | 151, 263 | 23, 924 | 348, 872 | 23, 188 |
| Columbus-Monroe Doctrine (*cer*) | 646 | 5, 083 | 4, 370 | 17, 322 | 154, 533 |
| Copper Age (*c*) | 3 | 1, 062 | 266 | 24, 575 | ---------- |
| Distaff (*c*) | 93 | 55, 883 | 1, 392 | 149, 600 | ---------- |
| Elkhart (*c*) | 662 | 10, 385 | 7, 482 | 245, 199 | ---------- |
| Empire and Silver Union (*c*) | 1 | 2, 475 | 122 | ---------- | ---------- |
| Eureka (*c*) | 7 | 2, 311 | 3, 371 | 23, 861 | 42, 714 |
| Flores (*cer*) | 422 | 366 | 172 | [illegible] | ---------- |
| George Washington (*m*) | 114 | 11, 059 | 15, 777 | [illegible] | ---------- |
| Golconda (*m*) | 20, 752 | 510, 180 | 354, 703 | 2, 031, 719 | 56, 226, 020 |
| Golden Eagle and Bobtail (*m*) | 1, 777 | 25, 845 | 890 | 40, 076 | ---------- |
| Golden Gem (*cer*) | 2, 478 | 8, 243 | 3, 365 | 14, 980 | ---------- |
| Hidden Treasure (*c*) | 251 | 9, 074 | 7, 897 | 159, 861 | 231, 345 |
| Idaho (*cer*) | 280 | 5, 285 | 4, 742 | 9, 348 | 51, 900 |
| Juno (*c*) | 1, 239 | 43, 128 | 4, 517 | 235, 498 | 154, 138 |
| Keystone (*m*) | 2, 703 | 452, 049 | 340, 778 | 348, 845 | 114, 063 |
| Little Chief (*s*) | 391 | 68, 351 | 2, 070 | 111, 825 | ---------- |
| Lucky Boy (*c*) | 1, 923 | 40, 438 | 230 | 8, 140 | ---------- |
| Mary Bell (*c*) | 26 | 955 | 557 | 19, 155 | 28, 733 |
| Midnight (*c*) | 44 | 8, 533 | 10, 746 | 4, 122 | ---------- |
| Minnesota-Connor (*c*) | 2, 890 | 228, 129 | 50, 702 | 169, 722 | 71, 053 |
| Mint (*m*) | 222 | 15, 265 | ---------- | ---------- | ---------- |
| New London (*cer*) | 13 | 3, 268 | 1, 558 | 136, 699 | 31, 243 |
| Nighthawk group (*m*) | 324 | 16, 297 | 5, 410 | 1, 589 | ---------- |
| Old Colony (*s*) | 21 | 2, 969 | 654 | 4, 370 | ---------- |
| Paymaster (*cer*) | 99 | 25, 090 | ---------- | ---------- | ---------- |
| Payroll (*c*) | 128 | 4, 104 | 11, 694 | 39, 928 | 192, 137 |
| Pinkham (*c*) | 56 | 14, 695 | 55, 136 | 3, 133 | ---------- |
| Rainbow (*c*) | 2, 400 | 34, 982 | 4, 748 | 313, 271 | 22, 426 |
| Redemption (*c*) | 21 | 4, 042 | 11, 449 | ---------- | ---------- |
| Rico (*s*) | 1, 149 | 15, 309 | 1, 449 | 2, 620 | ---------- |
| Samoa and Samoan (*c*) | 4, 480 | 57, 891 | 4, 454 | 656, 377 | 67, 886 |
| St. Louis (*cer*) | 24 | 11, 142 | 1, 050 | 855, 841 | 1, 496 |
| Silver Age (*c*) | 24 | 3, 550 | ---------- | ---------- | ---------- |
| Silver Hill (*c*) | 708 | 8, 842 | 10, 722 | 229, 949 | 143, 594 |
| Tennessee and Schuylkill (*c*) | 42, 383 | 1, 514, 187 | 839, 837 | 59, 897, 096 | 66, 805, 907 |
| Towne (*c*) | 144 | 6, 286 | 2, 108 | 5, 516 | ---------- |
| Vanderbilt (*cer*) | 1, 012 | 2, 119 | 327 | 2, 568 | ---------- |
| Washington and Washington Extension (*m*) | 58 | 2, 205 | 1, 610 | 1, 700 | ---------- |

*c*, Chloride camp; *m*, Mineral Park camp; *cer*, Cerbat camp; *s*, Stockton camp.

### FUTURE ECONOMIC IMPORTANCE OF THE DISTRICT

It is believed that the future economic importance of the district will lie chiefly in the base-metal content of the fissure veins. Most of the veins have not been explored sufficiently at depth to test the base-metal content and particularly the zinc content. On the basis of a geologic study of the veins in the district there is no reason for assuming that any of several other veins will not be as productive of lead and zinc as the Tennessee or Golconda veins. Future development work, particularly at greater depths, on the many miles of veins in the district may disclose several that will prove to be their equal or better.

## DESCRIPTIONS OF MINES AND PROSPECTS

Several inherent difficulties were encountered in attempting to obtain data on the many mines in the district. Most of the mines were worked for the high-grade silver or gold in the shallow oxidized parts of the veins. Operations generally ceased when the lower-grade primary sulfides were reached. The principal work in most of the mines was done many years ago, and most of them are now largely or entirely inaccessible owing to caving or flooding. A few mines are partly accessible, but generally such a small part of the mine workings is disclosed, commonly in the oxidized zone or unproductive parts of the drifts and crosscuts, that it is not possible to obtain much tangible information concerning ore bodies or reserves. Mine maps and records are generally lacking, and many of those available are of such character as to make their reliability very dubious. Even past records of such large-scale operations as the Tennessee-Schuylkill and Golconda mines leave very much to be desired.

During Schrader's (1909, pp. 54–118) visit to the district in 1907, most of the workings were accessible and information was relatively fresh in the minds of people consulted, so that his data on most of the mines still remain by far the most reliable source of published information even though considerable additional work has probably been done in many of them. Bastin (1924) describes a few mines in some detail, whereas the only mine Thomas (1949, pp. 700–703) describes in any detail is the Emerald Isle mine. Garrett (1938, pp. 117–119) has described the Tennessee-Schuylkill mine, and during August and September 1943 engineers of the United States Bureau of Mines obtained assay data (Haury, 1947) on about 30 mines in the district from records and from a sampling of mine dumps and parts of all the accessible mines.

A few of the mines for which worthwhile new data have been assembled, in addition to material previously published, are described on the following pages. Most of these are mines that have been the leading producers of lead and zinc (table 2), although some, such as the Aurora and Emerald Isle mines and the Gross prospects, are briefly described because they contain minerals not commonly found in the district.

### AURORA MINE

The Aurora mine is about a mile east-southeast of Chloride. The property consists of one unpatented claim (Aurora) leased by E. E. Vondriska from J. G. Blackwell, of Chloride. The mine was formerly worked on a small scale primarily for lead and silver in the oxidized zone, but it was being worked in 1943 for vanadium and lead. No ore had been shipped by Vondriska, but about 5 tons of vanadinite and



5 tons of lead ore were piled near the portal. The main workings consisted of a drift about 300 feet long bearing south along the vein. About 30 feet from the south end of the drift a winze 40 feet deep had been sunk on the vein.

The Aurora vein strikes north, is nearly vertical, and averages 4 feet in width. It can be traced southward from the mine for about 1,400 feet (pl. 18). About 275 feet south of the north end of the vein vanadinite crystals occur in open spaces in the wall rock of pre-Cambrian gneissoid granite along the west side of the vein. The crystal aggregates are erratically and sparingly exposed over an area about 15 feet long and 10 feet high. The vanadinite is associated with an iron-stained earthy material. This is the only occurrence of vanadinite observed or reported in the district.

### CHAMPION MINE

The Champion mine is about a mile southwest of Cerbat camp on the western front of the range at an altitude of about 4,000 feet (pl. 18). This mine is reported to be one of the first discoveries in the district, worked in its early history chiefly for gold, silver, and lead. Table 2 shows that the mine has produced a substantial amount of zinc during its later operations. No reliable information could be obtained concerning the extent of the mine workings or the more recent operations. The mine was idle when visited, and all the workings were inaccessible.

The vein on which the mine is situated strikes about N. 50° W. and dips about 75° NE. It can be traced on the surface for a little more than 1,000 feet. A minette dike averaging about 6 feet in width lies alongside the southeastern part of the vein (pl. 18). Schrader (1909, p. 104, fig. 15) shows a section of the vein and dike sketched at the mine near the surface. Metallic sulfides observed on the mine dump include pyrite, galena, sphalerite, and a very minor amount of chalcopyrite; all are contained in quartz gangue.

### EMERALD ISLE MINE

An unusual type of copper deposit is found at the Emerald Isle mine, located about a mile west of Mineral Park, Wash. The mine was idle when visited early in 1943 and again in 1950. It was worked at various times from 1917 to 1943, and late in 1943 the Emerald Isle Copper Co. resumed mining and began the erection of a 300-ton leaching plant, which was completed in 1944. Mining continued until June 1946. In 1947 the Lewin-Mathes Co. started operations on the property and continued work until June 1948. About 55,000 tons of copper was recovered from the ores during the period 1943–48.

From the above considerations it is concluded that the mineralization has resulted from deposition of chrysocolla by ascending hypogene solutions that rose along one large and many small fissures and spread out into the adjacent alluvium. The conclusion is supported by the fact that the deposit was formed under essentially surface conditions. The main fissure and some of the associated minor fractures undoubtedly reached the original surface. In such an environment ascending hypogene solutions would be under the same pressures and could very easily have the same temperatures as the supergene solutions that deposit chrysocolla. And there is no reason why copper and silica could not be present in the proper amounts to form chrysocolla from such hypogene solutions.

Thomas' theory of a primary origin for the chrysocolla of the Emerald Isle deposit is disputed by Searls (1950), who states in part:

Rather than to have unchallenged in the record the rather startling suggestion that this chrysocolla "resulted from deposition by ascending hypogene solutions that rose along one large and many small fissures and spread out into the adjacent alluvium." the writer begs leave to contribute the following:

Churn drilling by the Calumet and Arizona Company and development by many individuals and groups (some listed by Schrader), have demonstrated these many years that important, although probably non-commercial, amounts of disseminated copper are contained in "The Broncho" or mineralized belt associated with the granite-porphyry intrusions of Mineral Park, and covered by Mr. Thomas as the "Ithaca Peak disseminated sulphide deposit."

The higher elevation of this belt and the present occurrence of soluble copper in the run-off from it, through Mineral Park wash (to the extent that copper has been and is still recovered from it, by precipitation on scrap in certain seasons), has convinced many geologists that Emerald Isle chrysocolla originally derived from the sulphides connected with this mineralization a mile or more distant.

This writer shared the skepticism of Mr. Thomas as to likelihood of the transfer, and still more of the localization, of the (circa) ten thousand tons of copper now known to exist in the secondary ore of Emerald Isle, from the Mineral Park disseminations; the more so as on the basis of present topography, higher bedrock separates the discharge of Mineral Park wash and the Emerald Isle deposit, a mile to the north of it. No chrysocolla deposits are known to exist in the bottom of the Gila conglomerate in the area currently receiving the waters of Mineral Park wash.

Equally unacceptable is the theory that the "vein" at Emerald Isle was the source of primary ore. The "vein" is one of a series of post-Gila faults that step down the pediment of the Cerbat Range and develop the graben of the Sacramento Valley, where the Gila and other agglomerate is very deep. Several of these faults are nearly parallel; and while only two are indicated by the topography, seismic work discloses others, successively stepping the bedrock down to the west and deepening the overburden on the basal layer.

As has been pointed out by several engineers, the "vein" ceases to be a vein below the depth at which it ceases to have the Gila conglomerate on one wall. Below its dip shift, the fault is unmineralized. Whatever the source of the copper, the emplacement of the chrysocolla (and copper pitch) in its present position has been brought about by a process equivalent to that, under which the African and Australian laterites accumulate. Acid copper-bearing solutions have at certain seasons over a long period of years trickled along the bedrock of this area and, as the rainy season yielded moisture to the pull of the sun, have been raised by capillary action into the lower layers of the gravel. Banding in the distribution suggests that certain of the layers contained a little calcium carbonate—as caliche—but not enough to exhaust the acid supply. Not only at the intersection of the "vein," but also at other small slips and irregularities in the conglomerate, the capillary action and perhaps osmosis has sucked the green water higher along these avenues of better circulation and, as Thomas says, the "veinlets pinch out upward" and "the chrysocolla filling apparently was deposited by ascending solutions." They ascend, however, only from the top of bedrock.



As this conclusion, amply supported—in the writer's judgment—by observation in the present workings, leaves unanswered the ultimate source of the copper, Mr. Arthur Storke and the writer, last year, in behalf of Climax Molybdenum Company and Newmont Mining Corporation, conducted geophysical surveys over the area, using a method that detects disseminated sulphides—whether of iron or copper. Briefly, the work resulted in the discovery of a large mass of "protore," lying adjacent to and east of the chrysocolla deposit. This rock carries from 1% to 2½% sulphide, and is too low in copper content to warrant drilling. At one small area, this remnant of a "porphyry copper" actually emerges east of the cover, and presents the gossan of a disseminated body of pyrite carrying perhaps 0.2% Cu.

There is little doubt that this dissemination (extending over several hundred acres) constitutes the roots or protore of a more important—and possibly at one time commercial—"porphyry," of which the secondary enrichment occurred, as elsewhere in Arizona, in pre-Gila time. Despite its destruction, the verdure deriving from its wasting chalcocite still adorns the residues of its former cap and enclosing host rocks.

## GOLCONDA MINE

The Golconda mine, which has been the second-largest producer of zinc in the district (table 2), is located in Todd Basin about 1.5 miles north of Cerbat. The mine was worked at various times and by numerous operators between the years 1910 and 1942, and Schrader (1909, p. 100) reports mining prior to his visit to the district in 1906–7. In May 1943 Bulwark Mines, Inc., of Kingman, Ariz., obtained a 10-year lease from Pontiac Mines, Inc., of Los Angeles, Calif., on 20 claims distributed around and including the Golconda mine. E. E. Bollinger, of Kingman, is president of Bulwark Mines, Inc.

The mine was idle when visited. Almost the entire production dates from 1908 to 1917, but by far the greatest amount of zinc was produced between 1914 and 1917. In October 1917 a fire destroyed the mill and most of the other surface equipment. Only a few intermittent and very small scale attempts to resume operations have been made since the fire. The main shaft has caved, and most of the other workings are inaccessible owing to caving or flooding.

Reliable information on the underground workings is scant. The main shaft is on the Golconda, or Prosperity, vein at an altitude of about 4,375 feet. It is inclined to the northeast and is reported to have reached a depth below the surface of 1,400 feet, following down, or approximately down, the dip of the vein. The mine has 12 levels, and drifts along the vein are commonly about 600 to 1,400 feet long.

roughly the same distance northwest and southeast of the shaft. The 600-foot level, however, extends northwestward from the main shaft along the vein, intersecting the surface at a point about 2,400 feet beyond the shaft. Southeast of the shaft this level is reported to extend for 400 feet. No drifts are reported between the 1,200-foot level and the bottom of the shaft (1,400-foot level).

The Golconda vein strikes northwest and dips to the northeast (pl. 18). The angle of dip varies, but it is reported to average about 65° in the underground workings. The vein pinches and swells, ranging in thickness from 2 to 7 feet. On the surface the vein can be traced, chiefly by small prospect pits, for about 4,000 feet. Near its northwest end it splits into several branches, two of which form approximately parallel prongs and have opposing dips. The Oro Plata mine is located on the southwest prong. A branch, about 1,700 feet long, trending in a more northerly direction, is known as the Primrose vein.

The country rock is chiefly the pre-Cambrian complex, mostly granite. Numerous small, irregular bodies of the Ithaca Peak granite, too small to be shown on the geologic map, are exposed on the surface in the area along and adjacent to the trend of the vein.

The principal metallic minerals, as determined chiefly from material on the mine dumps, are sphalerite, galena, pyrite, and chalcopyrite, contained in a milky quartz gangue. Much of the sphalerite is dark brown to almost black. Sphalerite is greatly in excess of galena. This is in marked contrast to the Tennessee-Schuylkill mine, which has produced about the same amount of zinc as the Golconda mine (table 2) yet has produced almost as much lead as zinc.

Information of a general nature indicates that the best ore shoots on the Golconda vein were found northward from the main shaft for about 1,000 feet. Most of the ore has been removed from the surface to the 600-foot level. Reports vary greatly regarding the grade and quantity of ore left in the workings below the 1,000-foot level.

About 500 feet southeast of the shaft on the 700-foot level a crosscut to the southwest connects with the mine workings along the Tubb, or Middle Golconda, vein. One of the higher levels in the Golconda mine also is reported to be connected by a crosscut to the Tubb vein. The Tubb vein roughly parallels the Golconda vein and, like it, dips to the northeast. On the surface the Tubb vein is 350 to 600 feet distant from the Golconda vein. Four levels, with a total of about 3,500 feet of drifts, are reported on the Tubb vein.

## GROSS COPPER PROSPECTS

A low-grade deposit of chalcocite occurs on the Gross ranch near the western border of the main exposure of the Ithaca Peak granite



south of Mineral Park. The inaccessible mine workings are reported to consist of a 200-foot shaft and two drifts, each about 600 feet long. One drift is to the east, and the other is to the northeast. The workings were driven in 1926 by the C. and A. Mining Co. No ore has been shipped. Material on the mine dump shows malachite, azurite, and specks of chalcocite disseminated in minor quantities in pyritized and silicified granite. Several veinlets of chalcocite 0.05 to 0.2 inch thick were observed, and one such veinlet is reported to have been 2 inches thick. A few specks or paper-thin stringers of molybdenite also were seen. Native copper, occurring as small leaf forms, is reported to be present in minor quantities but was not observed during the visit to the prospect.

## GROSS MOLYBDENITE PROSPECTS

In Bismark Canyon, 1,400 feet east of the Gross ranch house, two adits have been driven to explore a low-grade molybdenite deposit (pl. 18). The work was done about 1926 by the C. and A. Mining Co., but no ore has been shipped. The adit on the north side of the canyon bears almost due north for about 800 feet. Molybdenite occurs most commonly in specks and small stringers in quartz veinlets that cut the Ithaca Peak granite. The veinlets are 0.02 to 1.5 inches thick, but thicknesses of 0.5 inch or less predominate. Some molybdenite occurs in small disseminated specks in the granite or as paper-thin stringers with little or no quartz.

The adit on the south side of the wash is inaccessible but is reported to bear a little east of south. Near its south end a crosscut to the east encounters a rhyolite dike about 20 feet wide in nearby exposures. The material on the dump shows numerous narrow molybdenite-bearing quartz veinlets and stringers of pyrite cutting the rhyolite. The minerals extend into the granite in the same manner that was noted where they are exposed in the adit on the north side of the wash.

## HIDDEN TREASURE MINE

The Hidden Treasure mine is nearly 2 miles southeast of Chloride on the lower western slope of the mountains (pl. 18). The property consists of five claims along and bordering the Hidden Treasure vein held by Frank H. Grannis, of Chloride. The mine has been worked intermittently for many years by numerous operators. Schrader (1909, p. 72) reports mining operations prior to his visit to the district in 1907. The mine has produced, in addition to gold, silver, and copper (table 2), a little more than 115 tons of metallic zinc and nearly 80 tons of metallic lead during the period of recorded production from 1901 to 1948.

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The mine workings, which were partly accessible when the mine was visited, include several shafts, three crosscutting adits bearing northeast, and three levels vertically spaced about 50 feet apart. Drifts total about 3,000 feet.

The Hidden Treasure vein, on which the mine is located, has an average strike of about N. 50° W. and dips steeply to the northeast. It is correlated with the vein on which the Emerson mine is located (pl. 18). The vein pinches and swells to thicknesses ranging from 0.5 to 15 feet. Many branches and spur veins are disclosed in the underground workings of the Hidden Treasure mine. Crosscuts indicate several thin veins, some of which are probably branches of the main vein, trending about parallel to it. These smaller veins or branches, with few exceptions, could not be traced on the surface.

The country rock is the pre-Cambrian complex of granite, gneiss, schist, and amphibolite. In numerous places the country rock adjoining the vein is greatly altered to sericite or impregnated with pyrite for distances ranging from a fraction of an inch to several feet. Locally seams or thin zones of gouge an inch or two thick border the quartz veins.

The metallic sulfides, which are in a quartz gangue, include pyrite, sphalerite, galena, and minor quantities of chalcopyrite. Ore shoots that were observed in the underground workings are generally small bodies only a few feet long and a foot or less thick consisting of an intimate mixture of the various metallic sulfides and little or no quartz.

### KEYSTONE MINE

The Keystone mine is in Mineral Park at an altitude of about 4,375 feet. Schrader (1909, p. 82) states that it was located in 1870 and that its surface ores were very rich in gold and silver, by reason of which it became the first important producer in the district. The mine, consisting of three patented claims, has changed ownership many times and, when visited, was reported to be owned by the Beach Estate. It was then idle, and water filled the underground workings and the shaft to a depth of about 50 feet below the surface. Table 2 indicates that the greatest values have been in silver and gold, although the mine has also produced substantial amounts of copper, lead, and zinc.

The mine was developed by a shaft, reported to be about 400 feet deep, and four levels at 150, 200, 300, and 400 feet. Drifting on the 150-foot level is reported to have reached a distance of 850 feet northwest of the main shaft and 450 feet southeast of it. On the 300-foot level drifts extend about 275 feet both northwest and southeast of the shaft. On the 400-foot level is about 125 feet of drifting, mostly to the northwest. The greater part of the ore above the 300-foot level is reported to have been worked out.



The vein on which the mine is located strikes northwest and dips to the northeast at angles ranging from about 65° to 80°. About 800 feet northwest of the shaft the vein splits into two main branches; the southern branch dips prevailingly to the southwest at a steep angle and near its west end cuts a wide rhyolite dike. Another vein about parallel to the main vein is reported to lie approximately 100 feet northeast of the Keystone shaft, although no evidence could be found of this vein in surface outcroppings northwest of the shaft.

Vein matter on the mine dump is milky quartz with abundant pyrite and lesser amounts of sphalerite, chalcopyrite, and galena. Argentite, although reported to be present in the ore, was not found.

### PAYROLL MINE

The Payroll mine is about 1.5 miles east of Chloride, near the head of Payroll Gulch, at an altitude of about 4,500 feet. The property, which includes the patented Payroll and Black Prince claims, is held by the Thomas B. Scott Estate. The property is an old one, having been located in 1887, and much of the early work consisted of shallow diggings along the Payroll vein chiefly for high-grade gold ore. Considerable mining had been done prior to Schrader's (1909, p. 62) visit to the district in 1907, as he reports three shafts, about 400 feet of drifts, over 600 feet of tunnels, and some crosscuts and stopes. The main shaft was 225 feet deep. The mine was idle and the workings were inaccessible when visited by the writer in 1943. The main shaft is now reported to be a little more than 600 feet deep. The mine was developed by four main levels, the 50-, 200-, 400-, and 600-foot levels. Drifting and stoping from these levels has extended chiefly southeastward along the vein, the maximum distance from the shaft being 500 feet on the 600-foot level. The total length of all drifts is reported to be about 2,000 feet.

Production from the mine during the period 1901–48, as given in table 2, shows that during these years the mine was essentially a producer of zinc, although the early, unrecorded production may have been mostly in gold and silver.

The country rock consists of many types of the pre-Cambrian complex, although light-gray, fine-grained granite, dark, medium-grained biotite granite, hornblende schist, and amphibolite predominate. A diabase dike, not shown on the geologic map, is poorly exposed for a short distance along the northeast side of the vein near the main shaft. It could not be found in its projected position on the northwest side of the gulch, and it apparently has been cut off by the northeastward-trending fault shown on plate 18.

### OTHER MINES AND PROSPECTS ON THE TENNESSEE VEIN

The Elkhart mine, at the extreme north end of the Tennessee vein, is an old mine that has been idle for many years. The total production from this mine from 1901 through 1948, as shown in table 2, has been small. The mine workings, now inaccessible, are reported to consist of three shafts, six levels (the lowest 500 feet deep), drifts totaling about 2,600 feet, numerous stopes, and several crosscuts.

The Silver Age mine, near the extreme south end of the vein, was primarily a silver mine (table 2). The silver was probably derived in large part from silver chloride (cerargyrite) found in the oxidized zone. Accurate data concerning the inaccessible mine workings could not be obtained. It is reported that the shaft is about 150 to 200 feet deep and that drifts and stopes extend northward from the shaft for some 200 or 300 feet. The vein material on the mine dump is partly oxidized, chiefly to iron hydroxides. Pyrite is the most abundant primary sulfide. Minor amounts of galena and sphalerite, together with sparse chalcopyrite, are associated with the pyrite in quartz gangue.

Several shafts have been driven and numerous pits and trenches have been dug along the Tennessee vein from the Silver Age shaft to the Tennessee shaft. The deepest of these is the Johnny Bull shaft (pl. 18), which is reported to be 88 feet deep. No drifting or stoping from this shaft is known.

Diamond drilling on the southern part of the Tennessee vein was carried out by the United States Bureau of Mines (Tainter, 1947) during the period from September 16 to December 8, 1943. The exploratory work consisted of eight drill holes on the Johnny Bull and Silver Knight claims, between 750 and 2,450 feet south of the Tennessee shaft. The holes were distributed along the vein at intervals ranging from 200 to about 375 feet. All holes were drilled from the surface and inclined toward the vein. Four were drilled from the west side of the vein outcroppings and the other four from the east side. Depths below the surface at which the vein was intersected ranged from about 100 to 350 feet, the deepest corresponding approximately in altitude to the 400-foot level in the Tennessee mine.

All holes intersected the vein, but the vein filling in seven of the eight cores was barren of ore minerals or was so low in grade as to be of little or no economic interest. The only hole that showed a substantial amount of the ore minerals was hole 8, located about 1,900 feet south of the Tennessee shaft. This hole intersected the vein about 100 feet below the surface, at an approximate altitude of 4,100 feet. A 3.5-foot interval of sphalerite, galena, and pyrite in quartz gangue assayed 7.6 percent zinc, 0.1 percent lead, and 0.03 percent copper.



This intersection might suggest that the top of an ore body was penetrated, but the Bureau of Mines engineers believed that the extensive drilling necessary to determine the existence of an ore shoot in the vicinity of hole 8 was not warranted.

### TURQUOISE MINES

Deposits of turquoise are restricted to the Ithaca Peak granite and occur most abundantly in the southern half of the main intrusive body south of Mineral Park, particularly on Ithaca and Turquoise Peaks. Many small and shallow workings have explored these deposits, and only the larger ones are shown on plate 18. Some of the diggings are very old, having been started by the Aztec Indians. Very little work has been done on the deposits for many years.

Turquoise occurs typically in veinlets and small lenses in silicified, sericitized, and kaolinized porphyritic granite. Turquoise most commonly fills cavities in quartz veinlets, although some is in altered granite. Other minerals sparsely associated with turquoise in a few places are malachite, chrysocolla, and hydrous iron oxides. Sterrett (1908, pp. 847–852) describes some of the individual deposits in this area.

The features of the deposits suggest a secondary origin by supergene processes similar to those given by Paige (1912) for the origin of turquoise in the Burro Mountains of New Mexico.

### LIST OF REFERENCES

The literature pertaining to the district is not extensive. The list given below includes the chief publications. Of these, Schrader's report on districts in Mohave County furnishes the most extensive description of the Wallapai district, and it is of particular value in furnishing descriptions of many of the mines. Thomas' manuscript contributes much information, particularly his detailed descriptions of the minerals and their paragenetic relationships. He includes a small-scale geologic map that covers an area extending from Mineral Park northwestward for several miles beyond Chloride. Most of the references are brief summaries of the geology and ore deposits, probably taken in part from Schrader's previous work.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
THOS. H. MILLER, ACTING DIRECTOR

REPORT OF INVESTIGATIONS

# EXAMINATION OF ZINC-LEAD MINES IN THE WALLAPAI MINING DISTRICT, MOHAVE COUNTY, ARIZ.



BY

P. S. HAURY

R. I. 4101,
August 1947.

REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

# EXAMINATION OF ZINC-LEAD MINES IN THE WALLAPAI MINING DISTRICT MOHAVE COUNTY, ARIZ.[1]

By P. S. Haury[2]

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1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 4101."

2/ Mining engineer, Bureau of Mines.

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ILLUSTRATIONS



## INTRODUCTION

Many ore deposits were discovered in the Wallapai Mining District, which covers the Cerbat Range in Mohave County, Ariz., during the early period of mining there from about 1865 to the 1890's. A considerable amount of production was obtained from shallow lead carbonate ores that carried considerable gold and silver.

Mining was revived in 1906 and again during the first World War, and some of the mines were deepened into the underlying sulfide zone. Substantial quantities of metal were recovered from two mines, the Golconda and the Tennessee-Schuylkill, that were developed to depths of 1,600 and 1,400 feet respectively. The Golconda is credited with $6,500,000 gross productions.3/

3/ Elsing, Morris J., and Heineman, Robert E. S., Arizona Bureau of Mines Bul. 140.

This mine was not operated after 1917. The Tennessee-Schuylkill is still operating after a yield of about 300,000 tons of ore that averaged 4.33 percent lead and 7.74 percent zinc and contained an appreciable amount of gold and silver.

Many of the old mines were reopened in 1942 or 1943 under the stimulus of premium prices for lead and zinc. A large proportion of this work was finished with loans from the Reconstruction Finance Corporation. It was believed that a good deal of lead and zinc could be recovered from the mines if a custom mill for concentration of the ores was available locally.

All the accessible mines in the Cerbat Range were examined by engineers of the Bureau of Mines[4] during August and September 1943, and many others were visited to make an estimate of the tonnage of ore that could be supplied to a custom mill at a central site near Chloride.

The information obtained on each mine visited was incorporated in a confidential War Minerals Report and is now presented in this report. Most of the accessible exposures of ore were sampled. The sample data are recorded in the reports on the individual mines. Some maps and sample data obtained from other sources are included in the mine reports. These are credited to their respective sources where they appear in the report.

The Mineral Park Milling Co. (F. J. McEntee, Jr., and D. F. Zlatnik) remodeled the old Keystone mill and began treating custom ore in July 1945. Production since September 1943 from all the mines in the district except the Tennessee-Schuylkill and the Emerald Isle was verified by the author on May 27, 1946. Production figures from mines that have loans from the Reconstruction Finance Corporation were obtained from that agency. Production data on other mines were obtained from the Mineral Park Milling Co.

The mines shipped 9,678 tons of ore in the 19 months from October 1, 1943, to May 1, 1946. The average grade of these shipments was 4.68 percent zinc and 0.54 percent copper. The average precious-metal content per ton was 0.094 ounce gold and 5.54 ounces silver.

## ACKNOWLEDGMENTS

In its program of investigation of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the investigative work, and prepares the final report. The Metallurgical Branch, O. C. Ralston, chief, analyses samples and performs beneficiation tests.

4/ Curtis G. Mohney and Robert M. Grantham.

Acknowledgment of general direction of the work here reported is due J. H. Hedges, district engineer, and S. R. Zimmerley, regional engineer for the Western Region.

Concentration tests were made in the testing laboratory at Salt Lake City on a bulk sample from the Summit mine under the direction of C. H. Schack and H. G. Poole.

## LOCATION AND ACCESSIBILITY

The Wallapai Mining District includes the Cerbat Mountains, which trend north-northwest for about 30 miles from near Kingman, a station on the Santa Fe Railroad. Paved U. S Highway 93 runs northwestward from Kingman through the Detrital Valley on the west side of the Cerbat Range to Boulder Dam and Las Vegas, Nev. A good paved road 4 miles long connects Chloride, the only active camp in the district, with this highway at a point 19 miles north of Kingman. Most of the mines are situated near Chloride or near the abandoned camps of Mineral Park, Golconda, and Cerbat, which lie within the mountain range south of Chloride. The majority are on the west slope of the range at altitudes ranging from 4,000 feet at the foothills to 5,700 feet at the crest of the range. A few of the mines are on the east slope. All the mines are connected by roads with Chloride, with the paved highway, or with Kingman. Parts of a few of these roads are in such a state of disrepair as to be virtually impassable. The claim map (fig. 1) shows the location of the several mines covered in this report.

## HISTORY

Many ore deposits were discovered in this district during the period from the late 1860's through the 1890's, and considerable production was obtained, chiefly from lead carbonate ores near the surface that were mined for their gold and silver content. Activity was revived during 1906 to 1912 and again during the first World War, when deeper development was done at some of the mines, and some galena ores, containing gold and silver, were produced.5/ Two mines were developed to considerable depth and yielded notable production. The Golconda mine, in the southern part of the range, was developed to a depth of 1,600 feet and yielded about $6,500,000 worth of ore to 1917. In that year the mill was destroyed by fire, and the property has not been operated since. The Tennessee-Schuylkill mine, near Chloride, has been developed to a depth of 1,400 feet. The mine is still in operation after a yield of about 300,000 tons of ore averaging 4.33 percent lead and 7.74 percent zinc and having an appreciable gold and silver content.

## PHYSICAL FEATURES

The topography at the mines ranges from comparatively gentle slopes at the foot of the range to rugged mountain slopes in the heart of the range.

5/ Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: Geol. Survey Bull. 397, 1909, 226 pp.

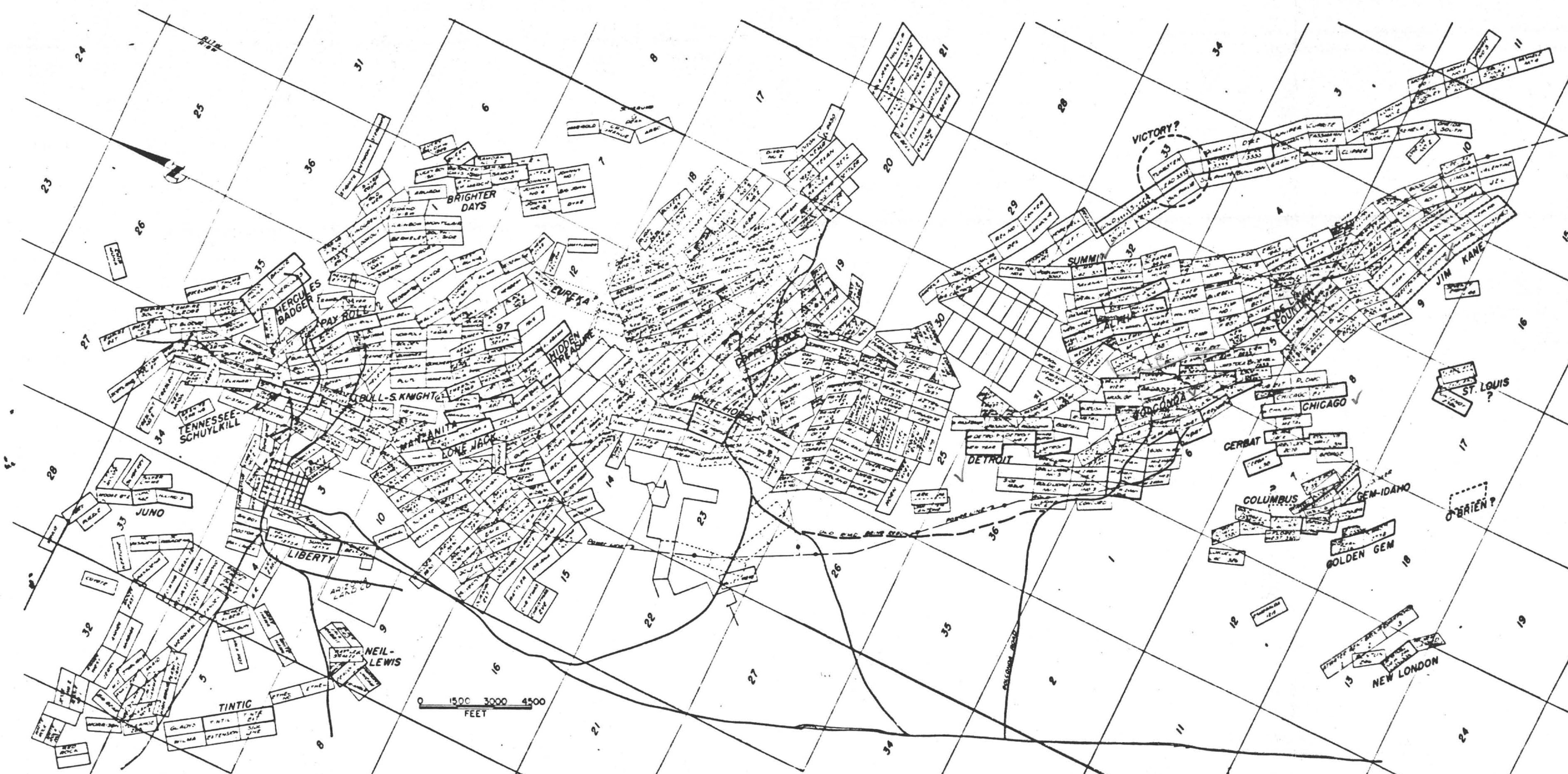



Figure 1. - Claim map of Wallapai mining district, Mohave County, Ariz.

Roads to the mines near the crest have sharp curves and steep grades. The climate is arid, and the vegetation is sparse and stunted. Owing to the altitude, the summers are not extremely hot. Winters are mild.

The most practical site for a custom mill would be on the desert floor near the entrance to the Mineral Park basin. This location is fairly central and is easily accessible from all directions. Enough water could be obtained from the surface flow in the canyon out of the Mineral Park basin and from old shafts within the basin, which has a considerable drainage area. Water from these sources need not be piped very far.

## ORE DEPOSITS

The area is underlain by pre-Cambrian schist, amphibolite, and altered granite, which have been intruded by later granite porphyry. Much of the schist is amphibole. Many veins occur in nearly vertical fault fissures that strike northwestward and outcrop for considerable distances. The fault fissures are largely occupied by breccia and gouge with discontinuous lenses of lead and zinc ores. Most of the ore lenses now exposed contain quartz, sphalerite, galena, and pyrite, with minor amounts of chalcopyrite and usually a fair amount of gold and silver. Oxidation generally extends about 70 to 150 feet below the surface. Most of the oxidized ore was mined during earlier operation. The ore lenses generally are not extensive and do not seem to be distributed according to any regular pattern. Frequently they do not fill the entire fault fissure and have walls of breccia and gouge that need support while the ore is being mined. This is not universally true. There are some quartz veins with solid walls that stand well.

## RECENT DEVELOPMENTS

A number of the old mines were reopened in 1942 and 1943, and some new development work has been done at some of them. Part of this work was privately financed, but more of it was financed with loans from the Reconstruction Finance Corporation. Reports on the individual mines examined follow.

## CUSTOM MILL

F. J. McEntee, Jr., and D. F. Zlatnik, operating as the Mineral Park Milling Co., remodeled the Keystone mill and began milling custom ore in July 1945. The mill has four receiving bins. Shipments from the individual mines are accumulated and milled separately. Lead and zinc concentrates are made. Zlatnik reported, on May 28, 1946, that the ore treated had gradually increased to about 1,000 tons per month, and that shipments had been received from seven mines in May. He anticipated a considerably greater tonnage after the ceiling price and premium rates for the next fiscal year are fixed. The mill capacity is about 75 tons per day.

The ore-purchasing schedule, calculated on 50 percent lead concentrate and 50 percent zinc concentrate, follows:

## DETROIT MINE

### Location, Accessibility, and Ownership

The Detroit mine is situated about 6 miles south of Chloride. A good, graded road leads to the property, which lies 1/4 mile south of the road to the Summit mine. The spur road to the Detroit mine continues southward to the Golden Eagle mine, which adjoins the Detroit on the south.

The Detroit group of four claims is owned by Sam Norris of Kingman.

### History

The early work on the Detroit mine dates back to about the 1860's. This was directed toward the exploration and extraction of gold ores, as shown by the mining of the oxidized portion of the vein and rejection of the sulfide ores which contain zinc. The claims had been abandoned and were relocated by Norris in 1938. No attempt was made to develop the mine until recently, when development loans were obtained from the Reconstruction Finance Corporation.

### Production

No figures on early production were obtainable. The size of an old stope indicates that about 100 tons of ore was extracted from it. This was in the oxidized footwall portion of the vein. The sulfide ore on the hanging wall was not disturbed. It appears that some ore was mined from open cuts on the outcrop.

### Ore Deposits

The ore occurs in a fault fissure in amphibolite and granite that outcrops for a length of 200 feet and is 3 to 14 feet wide. This strikes N. 35° W. and dips 76° southwest. The fissure filling consists of quartz, fragments of granite and schist, and gouge. Metallization occurred along the walls of this fissure, leaving barren material in the middle. Sulfide ore, carrying pyrite, galena, sphalerite, and chalcopyrite, occurs on the hanging-wall side. There is up to 4 feet in width of ore on the footwall side that is oxidized near the surface. The early mining was done in this oxidized ore-shoot.

### Development

A crosscut adit, driven some 300 feet southeasterly, intersected the vein at 270 feet from the portal and 100 feet below the outcrop. A south drift on the vein from the crosscut is 90 feet long, and a north drift is 20 feet long. The south drift was started on the footwall but was turned to the hanging wall at 35 feet from the crosscut. A winze was sunk 100 feet on the footwall of the vein from the end of the north drift. The operator plans to crosscut to the hanging wall at the bottom of the winze and then sink 50 feet farther. Water was encountered 95 feet below the adit level. This enters so fast that little progress can be made in the winze until a pump that was ordered is installed.

| BUREAU OF MINES SAMPLES | | | | | | |
|---|---|---|---|---|---|---|
| NO. | WID. | % PB | % ZN | % CU | OZ. AU | OZ. AG |
| 3256 | 5.0' | 0.1 | 7.0 | 6.02 | .010 | 13.90 |
| 3257 | 4.9' | 0.2 | 4.4 | 3.70 | .005 | 7.75 |
| 3258 | 4.5' | 0.4 | 6.6 | 0.99 | TR | 6.10 |
| 3259 | 3.8' | 0.1' | 4.7 | 1.24 | .005 | 6.30 |
| 3260 | 3.5' | 0.1 | 4.5 | 0.92 | TR | 4.25 |
| 3261 | 4.0' | 0.1 | 4.2 | 1.02 | TR | 2.80 |
| 3262 | 3.0' | 0.1 | 1.8 | 0.81 | TR | 1.25 |
| 3263 | DUMP | 0.1 | 3.7 | 0.35 | TR | 1.55 |

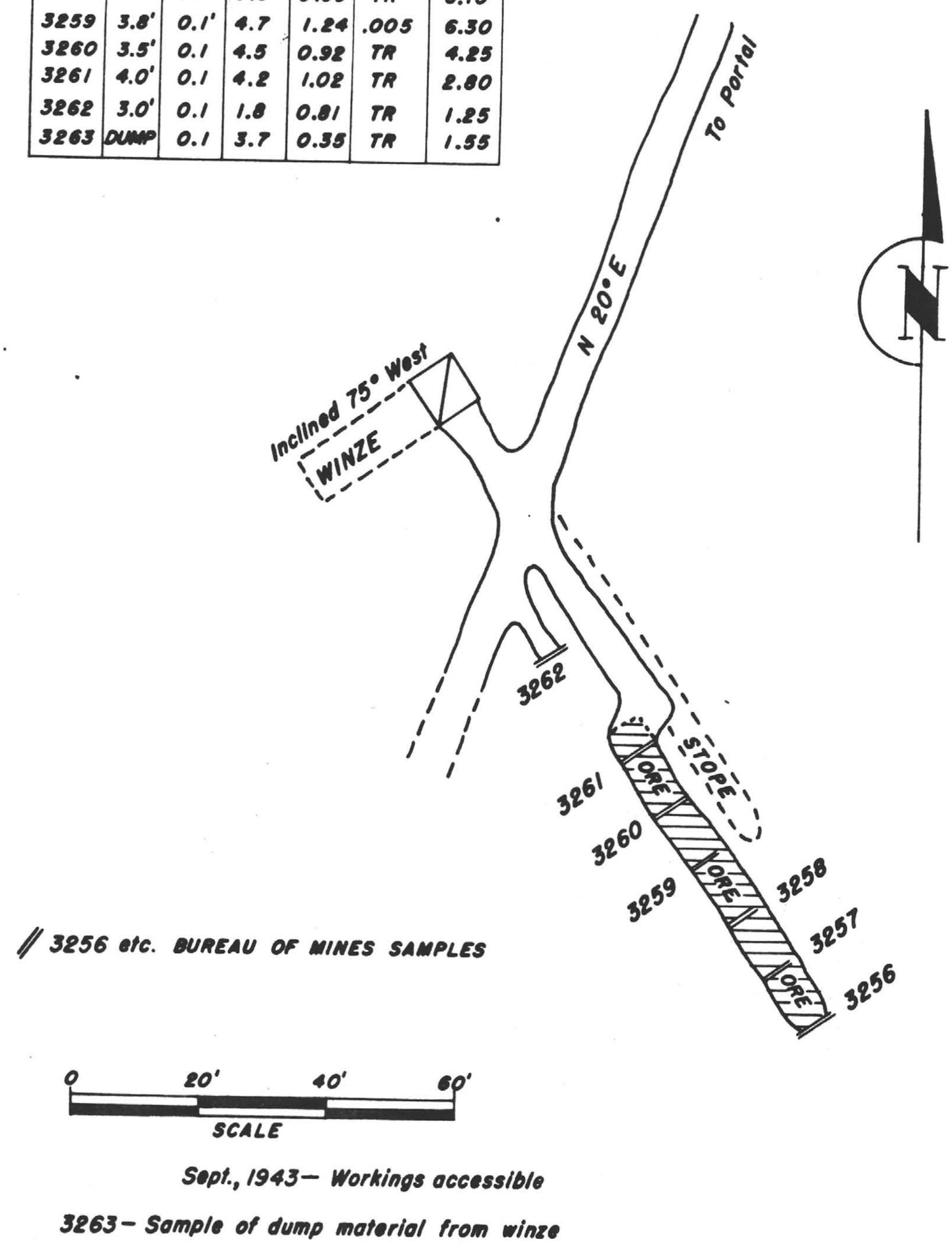



Figure 8. - Sample map of Detroit mine.

A small stope was mined from the oxidized footwall ore just south of the crosscut on the adit level. Two shallow shafts, 40 and 50 feet deep, were sunk on the outcrop. The 50-foot shaft is over the south drift on the adit level. An old adit was driven about 1,000 feet northwest of the portal of the working tunnel, and some drifting was done on a vein. That work is inaccessible.

## Sampling

A grab sample of the muck from the winze assayed 3.7 percent zinc, 0.1 percent lead, 0.35 percent copper, and 1.55 ounces per ton silver. The winze could not be sampled without interrupting the work in progress.

Seven samples were cut in the south drift. The samples show that there is a width of about 5 feet of mill-grade ore in the last 55 feet of the drift. The samples from this part of the drift averaged 0.3 percent lead, 5.3 percent zinc, 2.50 percent copper, and 7.2 ounces silver per ton. The sample locations and detailed sample data are shown on figure 8.

An old shaft above the south drift shows evidence that the vein is completely oxidized down to 50 feet above the drift. The face of the drift is very near the end line of the claim.

This ore shoot extends across the south end-line of the Detroit claims into the Golden Eagle ground. Open cuts on the oxidized outcrop of the vein show low metal values for some distance south of the common end line. If later development should prove that this ore shoot extends downward to the lower level, then the extension of the ore shoot in the Golden Eagle ground could be extracted through the Detroit workings. The Golden Eagle has lain idle for a long time. It was worked during an earlier period through a shaft 1/2 mile farther south. The old workings are all caved but the dumps bear evidence that the workings were extensive.

No production was made after the mine was examined in September 1943.

## VICTORY MINE

The Victory mine, formerly known as the Wrigley, is situated on the east slope of the Cerbat Range, about 15 miles by road north of Kingman and 38 miles by road from Chloride.

F. Nelson attempted to rehabilitate caved and flooded workings with the aid of an R.F.C. loan. Entry to the mine was through a shaft reported to be several hundred feet deep and to have several levels driven on the vein. The work of reopening this shaft had been abandoned when it was visited by engineers of the Bureau of Mines. Subsequent flooding and some fresh caving has made the mine entirely inaccessible.

## SUMMIT MINE

### Location and Accessibility

The Summit mine is situated near the crest of the Cerbat range about 12 miles southeast of Chloride. It is reached from the west by a road that serves the Alpha, Detroit, and Golden Eagle properties also. A road from Kingman goes up the east side of the range to the mine. The higher sections of both these roads were in such a state of disrepair as to be almost impassable. An access-road proposal for the improvement of the road from the west to the Summit and Alpha mines was approved by the Bureau of Mines and was completed before July 1, 1945.

### Ownership

The Summit group of 40 claims is owned by L. L. Robinson of Los Angeles, Calif. It was leased to the El Dorado Rover Mining Co., but the lease was relinquished in August 1943.

### History

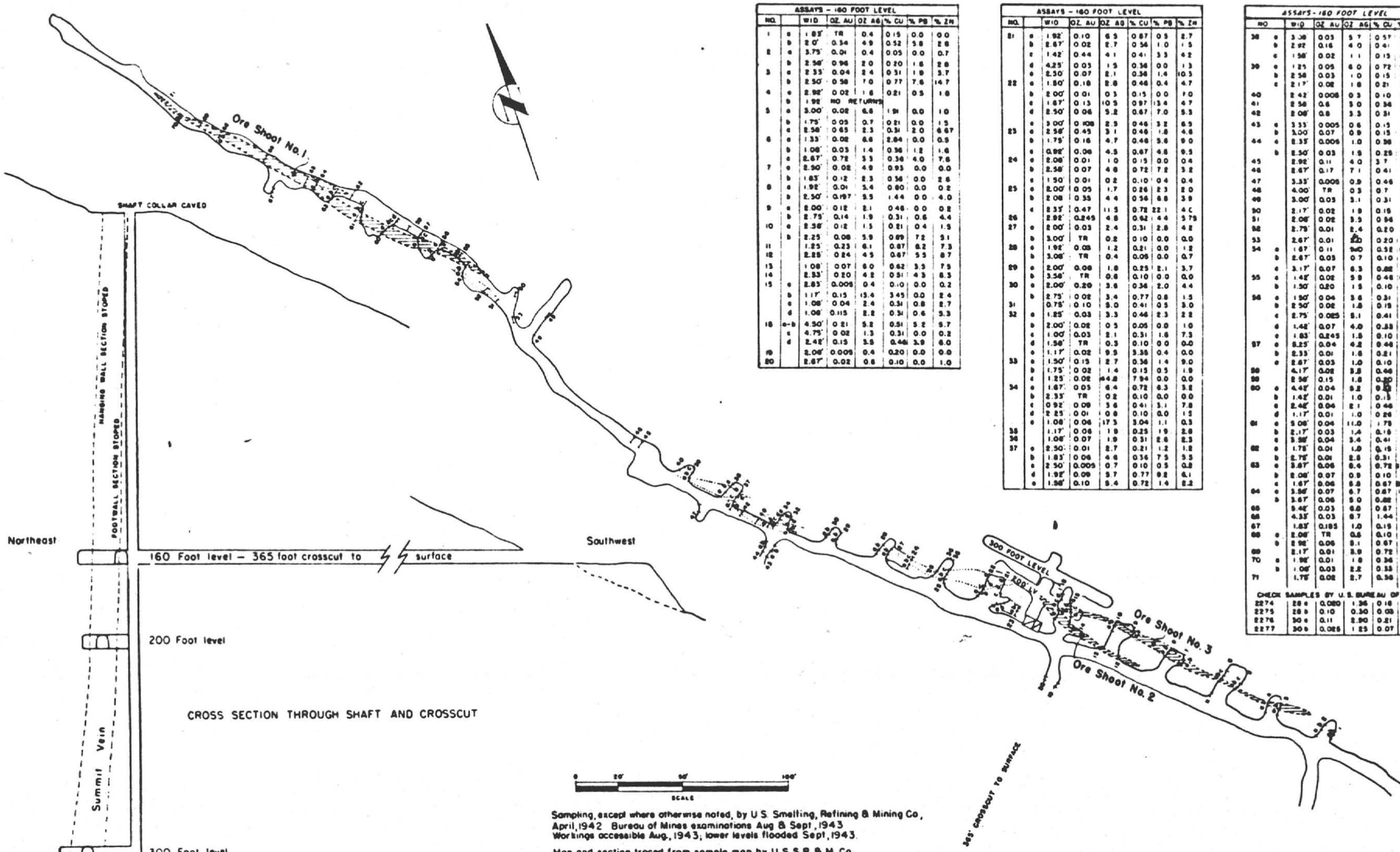
The U. S. Smelting, Refining & Mining Co., operating the mine on a lease, sank a vertical shaft in 1924. The Keystone Mining Co. shipped 12,000 tons of ore, which was stoped above the first level in 1936. The mine was thoroughly sampled in April 1942 by Miles P. Romney, engineer for the U. S. Smelting, Refining & Mining Co. The El Dorado Rover Mining Co. leased it in December 1942. This company did some new development on the lower levels with the aid of an R.F.C. loan and shipped 23 cars of ore, much of which was stoped above the first level. The company decided that not enough ore could be developed to supply a mill from this mine alone. It shut down in August 1943 and returned a second R.F.C. loan.

### Ore Deposit

The ore-bearing vein, which is 3 to 8 feet thick, occupies a fissure in granite and amphibolite that stand well with little timbering. It strikes northwesterly and dips steeply northeast. The principal gangue is quartz with a considerable amount of gouge. The ore minerals are galena, sphalerite, pyrite, and chalcopyrite, with some gold and silver. The sulfides are largely oxidized above the first level. The metal content is below ore grade in much of the vein. The material with sufficient concentration of the metallic minerals to constitute ore occurs in lenses that seldom occupy the full width of the vein. Some of these are too small to mine. Three ore shoots with sufficient volume to repay the cost of mining are exposed on the first level. One of these is developed on the second level also. Two of these shoots are lead-zinc ore and one is copper ore.

### Development

The mine was opened by a 1-1/2-compartment vertical shaft with levels at depths of 160, 200, and 300 feet. The 160-foot level has about 750 feet of

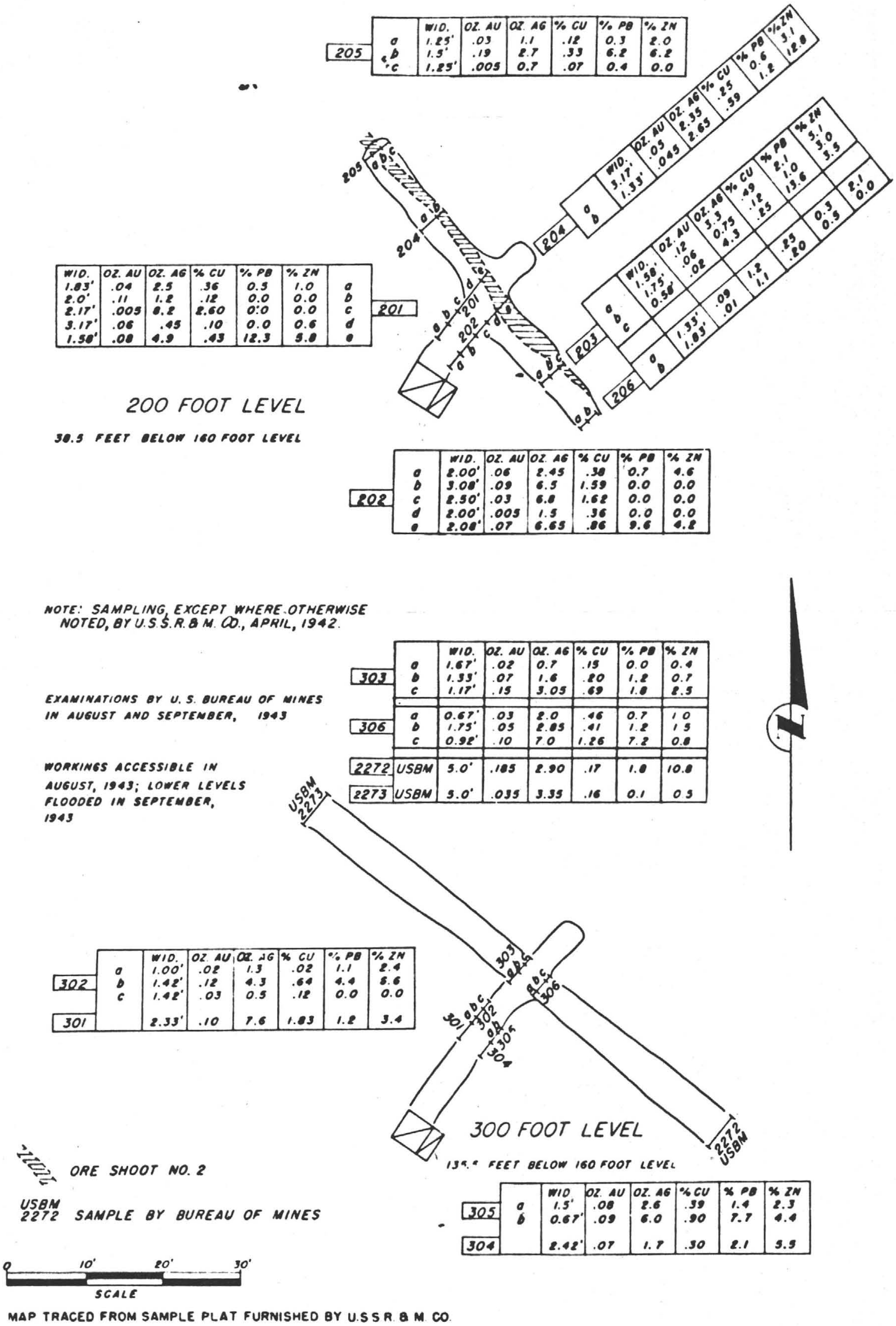



| ASSAYS – 160 FOOT LEVEL | | | | | | | |
|---|---|---|---|---|---|---|---|
| NO. | | WID | OZ. AU | OZ AG | % CU | % PB | % ZN |
| 1 | a | 1.83' | TR | 0.4 | 0.15 | 0.0 | 0.0 |
| | b | 2.0' | 0.54 | 4.9 | 0.52 | 5.8 | 2.8 |
| 2 | a | 3.75' | 0.01 | 0.4 | 0.05 | 0.0 | 0.7 |
| | b | 2.58' | 0.96 | 2.0 | 0.20 | 1.6 | 2.8 |
| 3 | a | 2.33' | 0.04 | 2.4 | 0.31 | 1.9 | 3.7 |
| | b | 2.50' | 0.58 | 7.0 | 0.77 | 7.6 | 14.7 |
| 4 | a | 2.92' | 0.02 | 1.6 | 0.21 | 0.5 | 1.8 |
| | b | 1.92' | NO RETURNS | | | | |
| 5 | a | 3.00' | 0.02 | 6.6 | 1.91 | 0.0 | 1.0 |
| | b | 1.75' | 0.05 | 0.7 | 0.21 | 0.0 | 1.5 |
| | c | 2.58' | 0.65 | 2.3 | 0.31 | 2.0 | 6.67 |
| 6 | a | 1.33' | 0.02 | 6.6 | 2.84 | 0.0 | 0.5 |
| | b | 1.08' | 0.03 | 1.4 | 0.38 | 1.2 | 1.6 |
| | c | 2.67' | 0.72 | 3.3 | 0.38 | 4.0 | 7.8 |
| 7 | a | 2.90' | 0.02 | 4.9 | 0.93 | 0.0 | 0.0 |
| | b | 1.83' | 0.12 | 2.3 | 0.38 | 0.0 | 2.6 |
| 8 | a | 1.92' | 0.01 | 3.4 | 0.80 | 0.0 | 0.2 |
| | b | 2.50' | 0.197 | 3.5 | 1.44 | 0.0 | 4.0 |
| 9 | a | 2.00' | 0.12 | 2.1 | 0.46 | 0.0 | 0.2 |
| | b | 2.75' | 0.14 | 1.9 | 0.31 | 0.6 | 4.4 |
| 10 | a | 2.58' | 0.12 | 1.5 | 0.21 | 0.4 | 1.5 |
| | b | 2.25' | 0.08 | 3.9 | 0.89 | 7.2 | 3.1 |
| 11 | | 1.25' | 0.23 | 6.1 | 0.87 | 8.2 | 7.3 |
| 12 | | 2.25' | 0.24 | 4.5 | 0.67 | 5.5 | 8.7 |
| 13 | | 1.08' | 0.07 | 6.0 | 0.62 | 3.5 | 7.5 |
| 14 | | 2.33' | 0.20 | 4.2 | 0.51 | 4.3 | 8.3 |
| 15 | a | 2.83' | 0.005 | 0.4 | 0.10 | 0.0 | 0.2 |
| | b | 1.17' | 0.15 | 13.4 | 3.45 | 0.0 | 2.4 |
| | c | 1.08' | 0.04 | 2.4 | 0.31 | 0.8 | 2.7 |
| | d | 1.08' | 0.115 | 2.2 | 0.31 | 0.6 | 3.3 |
| 18 | a-b | 4.50' | 0.21 | 5.2 | 0.51 | 5.2 | 5.7 |
| | c | 4.75' | 0.02 | 1.3 | 0.31 | 0.0 | 0.2 |
| | d | 2.42' | 0.15 | 3.5 | 0.46 | 3.9 | 6.0 |
| 19 | | 2.08' | 0.005 | 0.4 | 0.20 | 0.0 | 0.0 |
| 20 | | 2.67' | 0.02 | 0.6 | 0.10 | 0.0 | 1.0 |

| ASSAYS – 160 FOOT LEVEL | | | | | | | |
|---|---|---|---|---|---|---|---|
| NO. | | WID | OZ. AU | OZ AG | % CU | % PB | % ZN |
| 21 | a | 1.92' | 0.10 | 6.5 | 0.87 | 0.5 | 2.7 |
| | b | 2.67' | 0.02 | 2.7 | 0.56 | 1.0 | 1.5 |
| | c | 1.42' | 0.44 | 4.1 | 0.41 | 3.3 | 4.2 |
| | d | 4.25' | 0.03 | 1.5 | 0.36 | 0.0 | 1.3 |
| | e | 2.50' | 0.07 | 2.1 | 0.36 | 1.4 | 10.3 |
| 22 | a | 1.80' | 0.18 | 2.8 | 0.46 | 0.4 | 4.7 |
| | b | 2.00' | 0.01 | 0.3 | 0.15 | 0.0 | 1.0 |
| | c | 1.67' | 0.13 | 10.5 | 0.97 | 13.4 | 4.7 |
| | d | 2.50' | 0.06 | 5.2 | 0.67 | 7.0 | 5.3 |
| | e | 3.00' | 0.108 | 2.5 | 0.46 | 3.2 | 6.5 |
| 23 | a | 2.58' | 0.45 | 3.1 | 0.46 | 1.8 | 4.6 |
| | b | 1.75' | 0.16 | 4.7 | 0.46 | 3.6 | 9.0 |
| | c | 0.92' | 0.06 | 4.5 | 0.67 | 4.6 | 9.5 |
| 24 | a | 2.08' | 0.01 | 1.0 | 0.15 | 0.0 | 0.4 |
| | b | 2.58' | 0.07 | 4.8 | 0.72 | 7.2 | 3.2 |
| | c | 1.50' | 0.01 | 0.2 | 0.10 | 0.4 | 0.4 |
| 25 | a | 2.00' | 0.05 | 1.7 | 0.26 | 2.3 | 2.0 |
| | b | 2.08' | 0.35 | 4.4 | 0.56 | 6.8 | 3.9 |
| | c | 2.33' | 0.47 | 11.5 | 0.72 | 22.1 | 4.C |
| 26 | | 2.92' | 0.245 | 4.8 | 0.62 | 4.4 | 5.75 |
| 27 | a | 2.00' | 0.03 | 2.4 | 0.31 | 2.8 | 4.2 |
| | b | 3.00' | TR | 0.2 | 0.10 | 0.0 | 0.0 |
| 28 | a | 1.92' | 0.05 | 1.2 | 0.21 | 0.0 | 1.2 |
| | b | 3.08' | TR | 0.4 | 0.05 | 0.0 | 0.7 |
| 29 | a | 2.00' | 0.08 | 1.8 | 0.25 | 2.1 | 3.7 |
| | b | 3.58' | TR | 0.6 | 0.10 | 0.0 | 0.0 |
| 30 | a | 2.00' | 0.20 | 3.6 | 0.36 | 2.0 | 4.4 |
| | b | 2.75' | 0.02 | 3.4 | 0.77 | 0.8 | 1.5 |
| 31 | | 0.75' | 0.10 | 5.0 | 0.41 | 0.5 | 3.0 |
| 32 | a | 1.25' | 0.03 | 3.3 | 0.46 | 2.3 | 2.2 |
| | b | 2.00' | 0.02 | 0.5 | 0.05 | 0.0 | 1.0 |
| | c | 1.00' | 0.03 | 2.1 | 0.31 | 1.6 | 7.3 |
| | d | 1.58' | TR | 0.3 | 0.10 | 0.0 | 0.0 |
| | e | 1.17' | 0.02 | 9.5 | 3.35 | 0.4 | 0.0 |
| 33 | a | 1.50' | 0.15 | 2.7 | 0.36 | 1.4 | 9.0 |
| | b | 1.75' | 0.02 | 1.4 | 0.15 | 0.5 | 1.9 |
| | c | 1.25' | 0.02 | 44.8 | 7.94 | 0.0 | 0.0 |
| 34 | a | 1.67' | 0.03 | 6.4 | 0.72 | 6.3 | 3.2 |
| | b | 2.33' | TR | 0.2 | 0.10 | 0.0 | 0.0 |
| | c | 0.92' | 0.09 | 3.6 | 0.41 | 3.1 | 7.8 |
| | d | 2.25' | 0.01 | 0.8 | 0.10 | 0.0 | 1.5 |
| | e | 1.08' | 0.06 | 17.3 | 3.04 | 1.1 | 0.3 |
| 35 | | 1.17' | 0.06 | 1.8 | 0.25 | 1.9 | 2.8 |
| 36 | | 1.08' | 0.07 | 1.9 | 0.31 | 2.6 | 2.3 |
| 37 | a | 2.50' | 0.01 | 2.7 | 0.21 | 1.2 | 1.2 |
| | b | 1.83' | 0.06 | 4.6 | 0.36 | 7.5 | 5.5 |
| | c | 2.50' | 0.005 | 0.7 | 0.10 | 0.5 | 0.2 |
| | d | 1.92' | 0.09 | 5.7 | 0.77 | 9.2 | 6.1 |
| | e | 1.58' | 0.10 | 5.4 | 0.72 | 1.4 | 2.2 |

| ASSAYS – 160 FOOT LEVEL | | | | | | | |
|---|---|---|---|---|---|---|---|
| NO. | | WID | OZ. AU | OZ AG | % CU | % PB | % ZN |
| 38 | a | 3.30' | 0.03 | 5.7 | 0.57 | 9.6 | 3.5 |
| | b | 2.92' | 0.16 | 4.0 | 0.41 | 3.1 | 4.3 |
| | c | 1.58' | 0.02 | 1.1 | 0.13 | 0.4 | 0.2 |
| 39 | a | 1.25' | 0.05 | 6.0 | 0.72 | 9.1 | 6.7 |
| | b | 2.58' | 0.03 | 1.0 | 0.13 | 1.3 | 0.8 |
| | c | 2.17' | 0.02 | 1.0 | 0.21 | 3.8 | 2.0 |
| 40 | | 2.42' | 0.008 | 0.3 | 0.10 | 0.0 | 0.5 |
| 41 | | 2.58' | 0.6 | 3.0 | 0.38 | 3.8 | 3.0 |
| 42 | | 2.08' | 0.8 | 3.3 | 0.31 | 3.4 | 4.8 |
| 43 | a | 3.33' | 0.005 | 0.6 | 0.15 | 0.0 | 0.3 |
| | b | 3.00' | 0.07 | 0.9 | 0.15 | 0.0 | 2.7 |
| 44 | a | 2.33' | 0.006 | 1.0 | 0.08 | 0.8 | 0.4 |
| | b | 2.50' | 0.03 | 1.5 | 0.25 | 1.6 | 3.2 |
| 45 | | 2.92' | 0.11 | 4.0 | 3.7 | 0.3 | 2.7 |
| 46 | | 2.67' | 0.17 | 7.1 | 0.41 | 3.8 | 5.3 |
| 47 | | 3.33' | 0.006 | 0.9 | 0.46 | 0.0 | 0.5 |
| 48 | | 4.00' | TR | 0.3 | 0.7 | 0.0 | 0.5 |
| 49 | | 3.00' | 0.05 | 3.1 | 0.31 | 0.0 | 3.4 |
| 50 | | 2.17' | 0.02 | 1.9 | 0.15 | 0.0 | 1.4 |
| 51 | | 2.08' | 0.02 | 3.3 | 0.94 | 0.0 | 1.0 |
| 52 | | 2.75' | 0.01 | 2.4 | 0.20 | 2.7 | 3.0 |
| 53 | | 2.67' | 0.01 | [illegible] | 0.20 | 2.9 | [illegible] |
| 54 | a | 1.67' | 0.11 | 9.0 | 0.32 | 17 | 3.8 |
| | b | 2.67' | 0.05 | 0.7 | 0.10 | 0.0 | 0.7 |
| | c | 3.17' | 0.07 | 6.3 | 0.82 | 6.6 | 7.6 |
| 55 | a | 1.42' | 0.02 | 5.0 | 0.48 | 10.0 | 7.4 |
| | b | 1.50' | 0.20 | 1.5 | 0.10 | 0.4 | 1.0 |
| 56 | a | 1.50' | 0.04 | 3.6 | 0.31 | 3.5 | 1.0 |
| | b | 2.50' | 0.02 | 1.8 | 0.15 | 1.0 | 1.0 |
| | c | 2.75' | 0.025 | 5.1 | 0.41 | 3.5 | 0.0 |
| | d | 1.48' | 0.07 | 4.0 | 0.33 | 7.8 | 11.6 |
| | e | 1.83' | 0.245 | 1.8 | 0.10 | 0.0 | 0.0 |
| 57 | a | 2.25' | 0.04 | 4.2 | 0.40 | 4.0 | 5.2 |
| | b | 2.33' | 0.01 | 1.0 | 0.21 | 1.0 | 4.3 |
| | c | 2.67' | 0.03 | 1.0 | 0.10 | 0.0 | 0.0 |
| 58 | | 4.17' | 0.02 | 3.3 | 0.46 | 3.2 | 5.2 |
| 59 | | 2.58' | 0.15 | 1.0 | 0.80 | 1.1 | 3.3 |
| 60 | a | 4.42' | 0.04 | 9.2 | [illegible] | 6.6 | 9.4 |
| | b | 1.42' | 0.01 | 1.0 | 0.1 | 1.2 | 2.0 |
| | c | 2.42' | 0.04 | 2.1 | 0.46 | 0.8 | 0.0 |
| | d | 1.17' | 0.01 | 1.0 | 0.26 | 0.0 | 0.0 |
| 61 | a | 5.08' | 0.04 | 11.0 | 1.75 | 6.5 | 16.3 |
| | b | 2.17' | 0.03 | 1.4 | 0.18 | 1.0 | 1.4 |
| | c | 3.92' | 0.04 | 3.4 | 0.41 | 3.0 | 0.0 |
| 62 | a | 1.75' | 0.01 | 1.0 | 0.19 | 1.2 | 1.2 |
| | b | 2.75' | 0.01 | 2.8 | 0.31 | 1.0 | 5.0 |
| 63 | a | 3.67' | 0.06 | 8.4 | 0.72 | 6.6 | 6.3 |
| | b | 2.08' | 0.07 | 0.9 | 0.10 | 0.6 | 0.4 |
| | c | 1.67' | 0.06 | 5.8 | 0.57 | 20.2 | 8.8 |
| | d | 1.50' | 0.07 | 6.7 | 0.67 | 12.2 | 6.2 |
| 64 | a | 3.58' | 0.07 | 6.7 | 0.67 | 12.2 | 6.2 |
| | b | 3.67' | 0.06 | 5.0 | 0.62 | 5.3 | 16.5 |
| 65 | | 3.42' | 0.03 | 6.0 | 0.67 | 6.3 | 7.0 |
| 66 | | 4.33' | 0.03 | 8.7 | 1.64 | 3.8 | 11.3 |
| 67 | | 1.83' | 0.185 | 1.0 | 0.13 | 0.0 | 1.0 |
| 68 | a | 2.08' | TR | 0.8 | 0.10 | 0.3 | 0.3 |
| | b | 2.92' | 0.06 | 5.1 | 0.67 | 6.3 | 12.8 |
| 69 | | 2.17' | 0.01 | 3.9 | 0.72 | 4.4 | 4.3 |
| 70 | a | 1.92' | 0.01 | 1.0 | 0.36 | 0.9 | 0.3 |
| | b | 1.08' | 0.03 | 2.2 | 0.33 | 3.2 | 5.6 |
| 71 | | 1.75' | 0.02 | 2.7 | 0.36 | 1.6 | 7.8 |
| CHECK SAMPLES BY U. S. BUREAU OF MINES | | | | | | | |
| 2274 | | 28 in | 0.080 | 1.36 | 0.18 | 0.7 | 1.8 |
| 2275 | | 28 in | 0.10 | 0.30 | 0.03 | 0.3 | 0.8 |
| 2276 | | 30 in | 0.11 | 2.90 | 0.21 | 1.1 | 3.5 |
| 2277 | | 30 in | 0.025 | 1.25 | 0.07 | 0.3 | 0.7 |

Figure 9. - Elevation of Summit mine and sample plat of 160 ft. level.




| | | WID. | OZ. AU | OZ. AG | % CU | % PB | % ZN |
|---|---|---|---|---|---|---|---|
| 205 | a | 1.25' | .03 | 1.1 | .12 | 0.3 | 2.0 |
| | b | 1.5' | .19 | 2.7 | .33 | 6.2 | 6.2 |
| | c | 1.25' | .005 | 0.7 | .07 | 0.4 | 0.0 |
| 204 | a | 3.17' | .05 | 2.35 | .25 | 0.6 | 3.1 |
| | b | 1.33' | .045 | 2.65 | .59 | 1.2 | 12.8 |
| 201 | a | 1.83' | .04 | 2.5 | .36 | 0.5 | 1.0 |
| | b | 2.0' | .11 | 1.2 | .12 | 0.0 | 0.0 |
| | c | 2.17' | .005 | 8.2 | 2.60 | 0.0 | 0.0 |
| | d | 3.17' | .06 | .45 | .10 | 0.0 | 0.6 |
| | e | 1.58' | .08 | 4.9 | .43 | 12.3 | 5.8 |
| 203 | a | 1.58' | .12 | 3.3 | .49 | 2.1 | 5.1 |
| | b | 1.75' | .06 | 0.75 | .12 | 1.0 | 3.0 |
| | c | 0.58' | .02 | 4.3 | .25 | 13.6 | 3.5 |
| 206 | a | 1.33' | .09 | 1.2 | .25 | 0.3 | 2.1 |
| | b | 1.83' | .01 | 1.1 | .20 | 0.5 | 0.0 |
| 202 | a | 2.00' | .06 | 2.45 | .38 | 0.7 | 4.6 |
| | b | 3.08' | .09 | 6.5 | 1.59 | 0.0 | 0.0 |
| | c | 2.50' | .03 | 6.8 | 1.62 | 0.0 | 0.0 |
| | d | 2.00' | .005 | 1.5 | .36 | 0.0 | 0.0 |
| | e | 2.08' | .07 | 6.65 | .86 | 9.6 | 4.2 |

| | | WID. | OZ. AU | OZ. AG | % CU | % PB | % ZN |
|---|---|---|---|---|---|---|---|
| 303 | a | 1.67' | .02 | 0.7 | .15 | 0.0 | 0.4 |
| | b | 1.33' | .07 | 1.6 | .20 | 1.2 | 0.7 |
| | c | 1.17' | .15 | 3.05 | .69 | 1.8 | 2.5 |
| 306 | a | 0.67' | .03 | 2.0 | .46 | 0.7 | 1.0 |
| | b | 1.75' | .05 | 2.85 | .41 | 1.2 | 1.5 |
| | c | 0.92' | .10 | 7.0 | 1.26 | 7.2 | 0.8 |
| 2272 | USBM | 5.0' | .185 | 2.90 | .17 | 1.8 | 10.8 |
| 2273 | USBM | 5.0' | .035 | 3.35 | .16 | 0.1 | 0.5 |
| 302 | a | 1.00' | .02 | 1.3 | .02 | 1.1 | 2.4 |
| | b | 1.42' | .12 | 4.3 | .64 | 4.4 | 8.6 |
| | c | 1.42' | .03 | 0.5 | .12 | 0.0 | 0.0 |
| 301 | | 2.33' | .10 | 7.6 | 1.83 | 1.2 | 3.4 |
| 305 | a | 1.5' | .08 | 2.6 | .39 | 1.4 | 2.3 |
| | b | 0.67' | .09 | 6.0 | .90 | 7.7 | 4.4 |
| 304 | | 2.42' | .07 | 1.7 | .30 | 2.1 | 5.5 |

Figure 10. - Sample plats of 200 ft. and 300 ft. levels, Summit mine.

drift and has a second connection to the surface through a 365-foot adit. Drifts on the 200- and 300-foot levels are 50 and 65 feet long, respectively.

## Sampling

Detailed sample plats of the 160-foot, the 200-foot, and the 300-foot levels were furnished by the U. S. Smelting, Refining & Mining Co. (figs. 9 and 10). A few check samples were cut by the Bureau of Mines' engineers.

## Later Operation

The mine was leased by Ralph R. Langley of Kingman after it was released by the El Dorado Rover Mining Co. Langley assumed the unpaid balance due on the first R.F.C. loan to the former lessee. When the mine was visited by a Bureau of Mines' engineer[14] in December 1944, Langley had sunk a 50-foot winze on the 160-foot level, about 400 feet northwest of the main shaft, and drifted in both directions from the bottom of the winze. The winze is at the middle of the No. 1 ore shoot shown on figure 9. The sublevel is about 180 feet long. Ore was stoped continuously from this sublevel to the arch below the 160-foot level. This ore shoot was found undisturbed above the 160-foot level and was stoped to 20 feet from the surface. Langley reported that 3,800 tons of ore was mined from above the level. A total of 6,049 tons of ore was mined in the period from October 1943 through April 1946. This averaged 4.42 percent lead, 7.18 percent zinc, and 0.76 percent copper. The precious-metal content per ton was 0.0738 ounce gold and 5.82 ounces silver. The ore was shipped to the Keystone mill after that started operating. The truck haul is 8 miles with the grade against the load in the last 2.5 miles.

When the mine was visited on May 27, 1946, Langley had started drifting on the 300-foot level to continue the level about 500 feet northwest under the No. 1 ore shoot. The level had been advanced 65 feet northwest and also a little to the southeast.

Langley reported that they were entering good lead-zinc ore to the northwest and some copper ore to the southeast. He was beginning to stope this ore while the drift was being advanced.

## Concentration Tests

Concentration tests of a bulk sample taken from stope chutes were made in the Bureau of Mines testing laboratory at Salt Lake City. Selective flotation, after grinding to minus 65-mesh, recovered 86.8 percent of the lead in a concentrate that assayed 61.1 percent lead, 7.4 percent zinc, 2.1 percent copper, 1.87 ounces per ton gold, and 34.46 ounces per ton silver; 68.7 percent of the zinc in a concentrate that assayed 3.0 percent lead, 50.0 percent zinc, 1.5 percent copper, 0.30 ounce per ton gold, and 7.2 ounces per ton silver.

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14/ Chas. A. Kumke.

A third copper-iron concentrate assayed 24.0 percent copper, 0.27 ounce per ton gold, and 2.15 ounces per ton silver. The copper recovery in this concentrate was 65.4 percent.

## ALPHA MINE

### Location, Accessibility, and Ownership

The Alpha mine is situated about 1 mile from the Summit mine on the western slope and near the crest of the Cerbat Mountains in sec. 32, T. 23 N., R. 17 W. It is about 7 miles southeast of Chloride and 4 miles east of the old Kingman-Chloride highway. It is 4.5 miles by road from the highway to the Alpha mine. The road to the two mines was improved under the access road program prior to July 1, 1945.

The Alpha group of four claims is owned by Caroline Daniels Moore of Kingman. The mine has been leased to Ralph R. Langley, Box 455, Kingman, Ariz.

### History

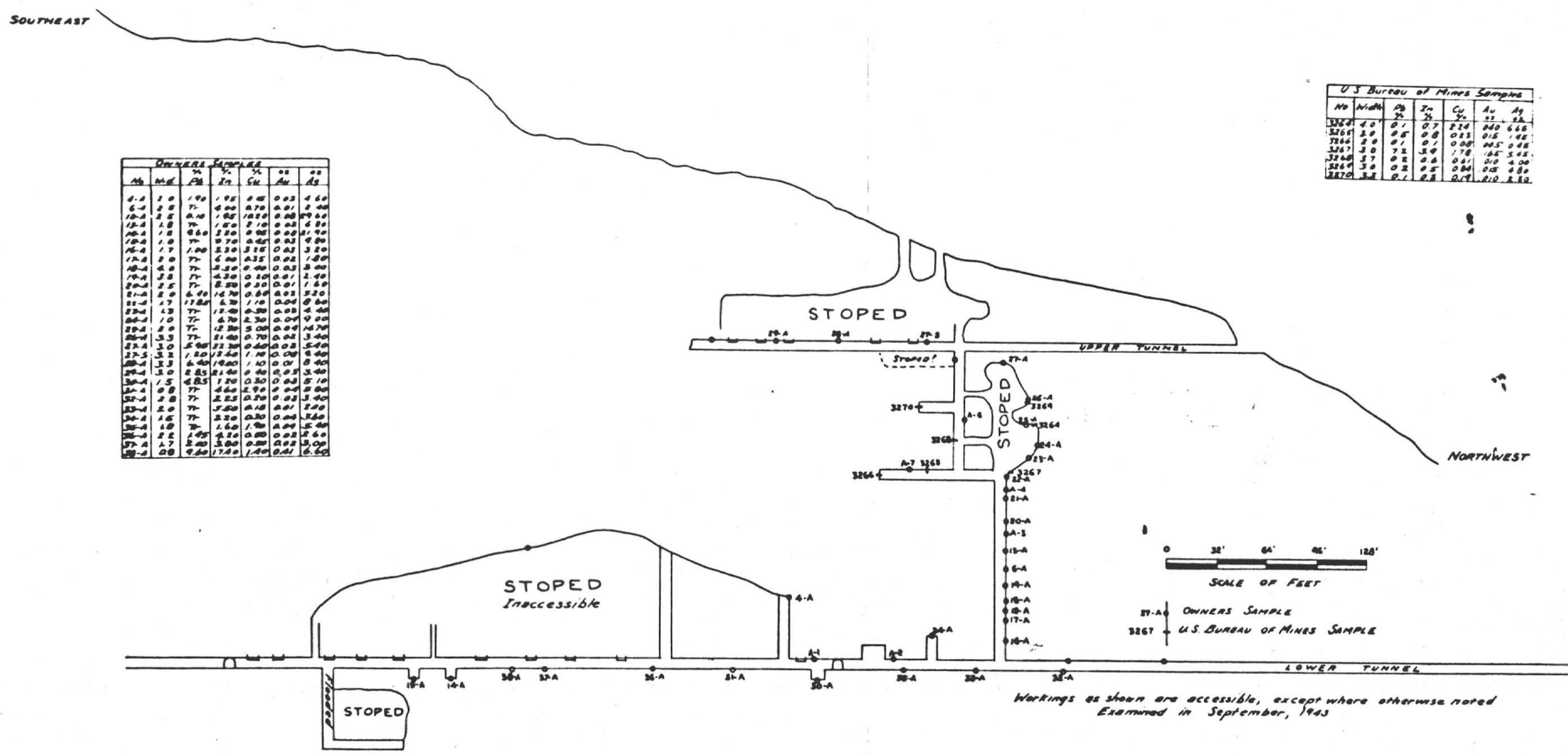
The mine was located in the late 1860's or early 1870's. It is reported that $200,000 worth of ore was taken from the mine and shipped. Part of this was from the oxidized zone and part from the sulfide zone. No records are available as to the grade or tonnage of the ore mined. The lower tunnel was partly cleaned out and retimbered with the aid of an R.F.C. loan. The greater part of the mine was accessible when the loan was exhausted and the work was suspended.

### Description of the Deposit

The ore occurs as lenses in a fissure vein in granite. This vein strikes N. 60° W. and dips 50° to 65° northeast. It is continuous and has a considerable amount of gouge for the greater part of its length. There is very little metallization except in the sulfide lenses. The principal minerals are quartz, galena, sphalerite, chalcopyrite, and pyrite. From the work done so far, it appears that the lenses have no connection with each other and that they do not occur in any regular pattern.

### Development and Mining

An adit was driven from the hillside a distance of 1,200 feet southeast on the Alpha vein (fig. 11). At a point 600 feet from the portal, a raise was driven 240 feet on the vein to connect with the upper adit or 200-foot level. This upper tunnel was driven from the surface a distance of 400 feet on the vein. From the lower level a stope over 300 feet long was carried to a height of 80 feet, according to mine maps. This stope has caved, and the back is inaccessible. A winze was sunk below the tunnel level, and it is reported that high-grade ore was taken from the winze and an adjoining stope. The winze is now flooded. A small stope has been mined from a sublevel off the raise to within a few feet of the upper tunnel. From the upper tunnel a




| Owners Samples | | | | | | |
|---|---|---|---|---|---|---|
| No | Wd | % Pb | % Zn | % Cu | oz Au | oz Ag |
| 4-A | 2.0 | 1.90 | 1.95 | [illegible] | 0.03 | 4.60 |
| 6-A | 2.5 | Tr | 4.00 | 0.70 | 0.01 | 2.40 |
| 10-A | 2.5 | 0.10 | 1.95 | 10.20 | 0.08 | [illegible] |
| 13-A | 1.8 | Tr | 1.50 | 2.10 | 0.02 | 6.80 |
| 14-A | 1.8 | 9.60 | 3.50 | 0.95 | 0.08 | 21.90 |
| [illegible] | 1.0 | Tr | 7.70 | 0.45 | 0.03 | 4.80 |
| 16-A | 1.7 | 1.00 | 3.30 | 3.15 | 0.03 | 3.20 |
| 17-A | 2.0 | Tr | 6.00 | 0.35 | 0.02 | 1.80 |
| 18-A | 4.0 | Tr | 3.50 | 0.40 | 0.03 | 3.00 |
| 19-A | 3.8 | Tr | 4.30 | 0.20 | 0.01 | 2.40 |
| 20-A | 2.5 | Tr | 8.50 | 0.30 | 0.01 | 1.60 |
| 21-A | 2.0 | 6.40 | 14.70 | 0.60 | 0.03 | 5.20 |
| 22-A | 1.7 | 17.80 | 6.70 | 1.10 | 0.04 | 8.60 |
| 23-A | 1.3 | Tr | 12.40 | 0.50 | 0.03 | 4.40 |
| 24-A | 1.0 | Tr | 6.70 | 2.30 | 0.04 | 9.00 |
| 25-A | 2.0 | Tr | 12.30 | 5.00 | 0.04 | 14.70 |
| 26-A | 3.3 | Tr | 21.40 | 0.70 | 0.02 | 3.40 |
| 27-A | 3.0 | 5.45 | 32.30 | 0.40 | 0.03 | 5.40 |
| 27-B | 3.2 | 1.20 | 13.60 | 1.10 | 0.08 | 9.40 |
| 28-A | 3.3 | 6.40 | 19.00 | 1.40 | 0.01 | 8.40 |
| 29-A | 3.0 | 2.85 | 21.40 | 0.40 | 0.05 | 3.40 |
| 30-A | 1.5 | 4.85 | 1.20 | 0.30 | 0.03 | 5.10 |
| 31-A | 0.8 | Tr | 4.60 | 2.90 | 0.04 | 5.00 |
| 32-A | 2.8 | Tr | 2.25 | 0.30 | 0.03 | 3.40 |
| 33-A | 2.0 | Tr | 5.50 | 0.15 | 0.01 | 2.00 |
| 34-A | 1.6 | Tr | 2.20 | 0.30 | 0.04 | 3.60 |
| 35-A | 1.8 | Tr | 1.60 | 1.90 | 0.04 | 5.40 |
| 36-A | 2.2 | 1.45 | 4.20 | 0.80 | 0.02 | 2.60 |
| 37-A | 1.7 | 2.00 | 3.00 | 0.50 | 0.02 | 3.00 |
| 38-A | 0.8 | 9.60 | 17.40 | 1.40 | 0.11 | 6.60 |

| U S Bureau of Mines Samples | | | | | | |
|---|---|---|---|---|---|---|
| No | Width | Pb % | Zn % | Cu % | Au oz | Ag oz |
| 3264 | 4.0 | 0.1 | 0.7 | 2.24 | .040 | 6.66 |
| 3265 | 2.0 | 0.6 | 0.8 | 0.23 | .015 | 1.46 |
| 3266 | 2.0 | 0.1 | 0.1 | 0.08 | .005 | 0.46 |
| 3267 | 3.0 | 7.2 | 3.4 | 1.78 | .165 | 5.45 |
| 3268 | 3.7 | 0.2 | 0.6 | 0.61 | .010 | 4.00 |
| 3269 | 3.0 | 0.2 | 0.5 | 0.04 | .015 | 4.80 |
| 3270 | 3.3 | 0.1 | 2.3 | 0.19 | .010 | 2.80 |

Figure 11. - Section in plane of vein - Alpha mine, Mohave County, Ariz.
Traced from map by Ralph Langley.

stope 150 feet long was mined to a height of 30 to 60 feet. This stope breaks through to the surface. Some ore was stoped from below the upper tunnel, and the stope was filled with waste. No work is being done at the present time, and most of the machinery has been removed from the property.

## Sampling

A copy of Langley's assay map of the Alpha mine was furnished to the Bureau of Mines and is included in this report. Most of these samples were taken at irregular intervals, and some of them were taken so as to include small bunches of high-grade ore. Seven samples were cut by the Bureau engineer to check the other sampling. The samples from the north side of the small stope off the main raise are mill-ore grade. The Bureau samples were cut across the entire exposed width of the vein. The two sets of samples are shown on the assay plat (fig. 11).

Detailed data on the sampling follow:

Bureau of Mines Samples

| No. | Location | Description | Length, foot | Assays | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Percent | | | Ounces | |
| | | | | Pb | Zn | Cu | Au | Ag |
| 3264 | N. side of stope below 200-ft. level, N. side | Heavy sulfides on foot and hanging wall | 4.0 | 0.1 | 0.7 | 2.24 | 0.040 | 6.65 |
| 3265 | Sublevel, 17 ft. south of raise. | Oxidized, little sulfide | 3.0 | .5 | .8 | .23 | .015 | 1.45 |
| 3266 | Sublevel breast. | Oxidized, altered granite | 2.0 | .1 | .1 | .08 | .005 | .45 |
| 3267 | Sublevel, N. end at top of ladder. | 1 foot with heavy sulfide | 3.0 | 7.2 | 3.9 | 1.78 | .165 | 5.45 |
| 3268 | Raise, 25 ft. above sub-level, S. side | Oxidized, some sulfides on footwall | 3.7 | .2 | .6 | .61 | .010 | 4.00 |
| 3269 | Stope below 200-foot level, N. side above platform. | Little sulfide | 3.0 | .2 | .5 | .84 | .015 | 4.80 |
| 3270 | Sublevel, 38 feet below 200-foot level. | Little sulfide, partly oxidized | 3.3 | .1 | .3 | .19 | .010 | 2.30 |

## Later Operation

One shipment of 64.8 tons of ore was made to the Keystone mill in 1945. This averaged 3.94 percent lead, 5.05 percent zinc, and 0.50 percent copper, with 0.07 ounce gold and 7.30 ounces silver per ton. Mr. Zlatnik, of the Keystone mill, reported that the ore responded exceptionally well to selective flotation. No work has been done at this mine in 1946.

## GOLCONDA MINE

The Golconda mine was one of the two deep mines of the district. The shaft was sunk to a depth of 1,600 feet, and extensive stoping was done above the 1,400-foot level. Production ceased when the mill burned in 1917. Total production to that time is reported at $6,500,000 in lead, zinc, gold, and silver.15/ The mine has been idle since 1917, although good ore was reported on the 1,400-foot level. The workings are badly caved, and the mine stands full of water to the adit on the 600-foot level.

## DE LA FOUNTAIN MINE

The De La Fountain claim is situated near the summit of the Cerbat Range, about 15 miles by road north of Kingman. It is owned by Messrs. Farley, Thomas, and Stevens of Flagstaff, Ariz., and is leased to L. M. Dickens of Kingman. The mine was operated recently and yielded two carloads of sorted ore in the last few months. The reported metal content of these shipments was 14 percent lead, 28 percent zinc, 0.02 ounce gold per ton, and 2.0 ounces silver per ton.

It is reported that four levels were opened in the course of the early mining. Only one is accessible. There are three stopes on this level, testifying to more substantial production during the earlier operation. The remaining ore on this level is in small pillars and along some of the stopes margins. The two carloads of sorted ore shipped by the present operator were gleaned from these stopes. Four samples, taken from such remnants of ore in the stopes averaged 3.6 percent lead and 14.2 percent zinc, with negligible gold and silver over widths of 1 to 4 feet.

## JIM KANE MINE

### Location, Accessibility, and Ownership

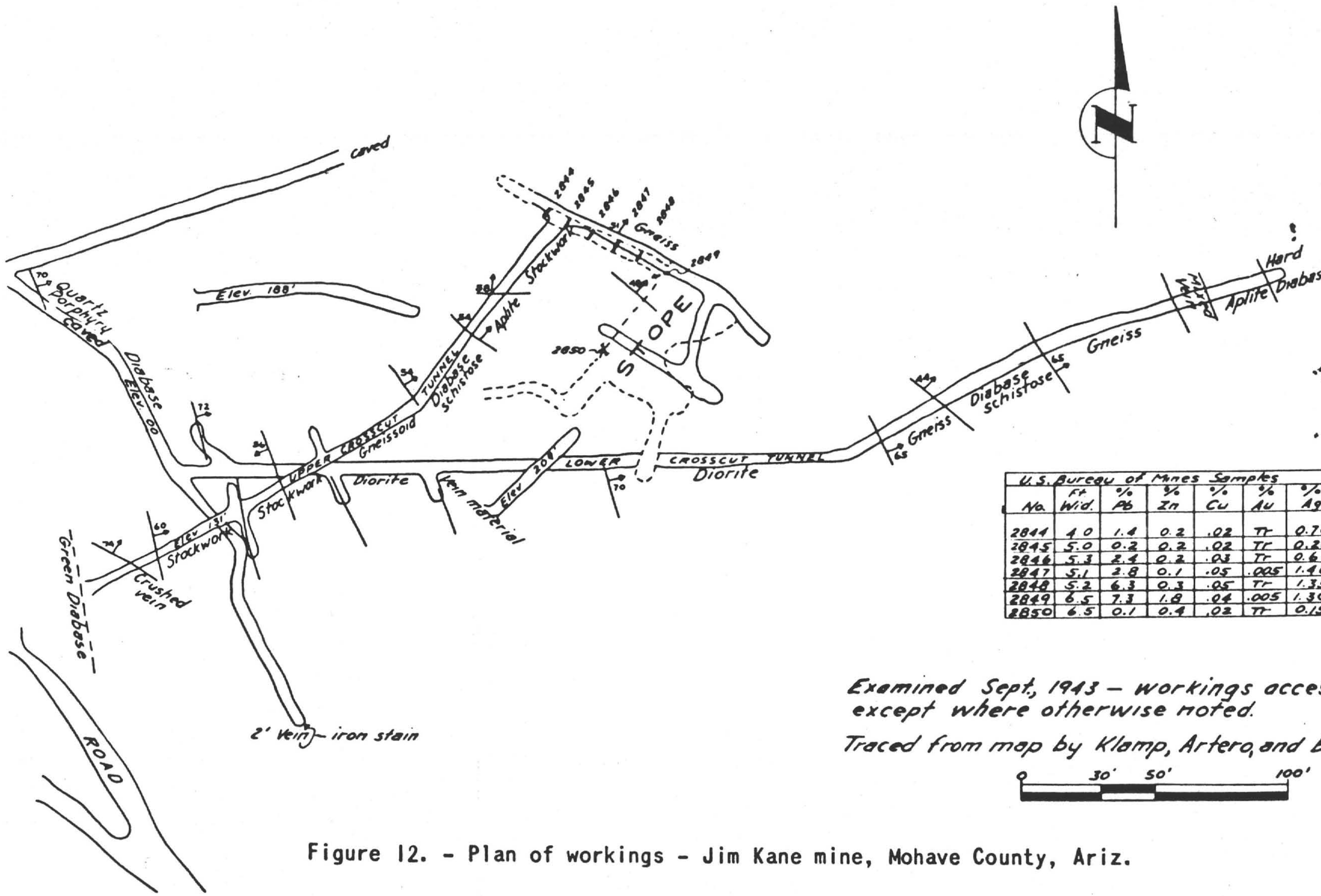
The Jim Kane mine is in Cerbat Canyon near the summit of the Cerbat range, 5.1 miles east of paved highway U. S. 93. The road to the property is in fair condition, but the grades are steep and the curves are sharp in the last 2 miles.

The group of 11 claims is owned by Jim Kane, of Kingman, who lives on the property.

### History

A small shaft was sunk to a depth of 30 feet during the early mining in this district. Jim Kane relocated the claims in 1915 and has held them to the present time. The California Chemical Spray Co. leased the property in 1939 and drove some drifts from the lower tunnel. After 6 months work they gave up the lease. No work is being done at present. It is reported that a

15/ Arizona Bureau of Mines, Arizona Metal Production: Bull. 140.




| U.S. Bureau of Mines Samples | | | | | | |
|---|---|---|---|---|---|---|
| No. | Ft Wid. | % Pb | % Zn | % Cu | % Au | % Ag |
| 2844 | 4.0 | 1.4 | 0.2 | .02 | Tr | 0.70 |
| 2845 | 5.0 | 0.2 | 0.2 | .02 | Tr | 0.20 |
| 2846 | 5.3 | 2.4 | 0.2 | .03 | Tr | 0.60 |
| 2847 | 5.1 | 2.8 | 0.1 | .05 | .005 | 1.40 |
| 2848 | 5.2 | 6.3 | 0.3 | .05 | Tr | 1.35 |
| 2849 | 6.5 | 7.3 | 1.8 | .04 | .005 | 1.30 |
| 2850 | 6.5 | 0.1 | 0.4 | .02 | Tr | 0.15 |

*Examined Sept, 1943 – workings accessible except where otherwise noted.*

*Traced from map by Klamp, Artero, and Blythe*

0 30' 50' 100'

Figure 12. - Plan of workings - Jim Kane mine, Mohave County, Ariz.

few cars of ore were milled at a local mill, and some ore was shipped direct to the smelter, but no figures were available as to the amount or grade of this production. Kane stated that a carload of ore had been shipped from the claim south of his house, which assayed 47 percent lead and 42 ounces per ton silver. This ore was packed out by burros. He also reported that during the first World War several hundred pounds of steel galena was sold for radio crystals at $0.25 to $1 per pound.

## Description of the Deposit

The ore occurs in brecciated and altered gouge material in a fault zone striking N. 60° W. and dips 60° northeast. This zone varies in width from 1 foot to 20 feet. The country rocks are amphibolite and gneiss intruded by dikes and irregular masses of younger granite porphyry. In the one accessible stope the galena occurs in small bunches and in small streaks in altered granite. Several tons of high-grade galena ore have been sorted and stored in the stope. The ore is very spotty, and hand sorting would be necessary to obtain a milling grade of ore. There are several minor fault zones of similar character that have been partly exposed in the workings (fig. 12). Small showings of lead and zinc minerals occur in these, but in general the small bunches of ore are more scattered than in the major fault zone described above. A little beryl has been found in two small outcrops of pegmatite on the claim at the south end of the group. Mr. Kane stated that he had picked up 20 or 25 pounds of crystals. Two small pieces were found on the outcrops by the Bureau engineers. The pegmatite does not seem to be a continuous dike, but rather two separate bunches. Both of the detached outcrops are small.

## Development

The underground workings are shown on figure 12, traced from an undated map by Klamp, Artero, and Blythe of the Producers Mining Co.

## Sampling

The prospect was thoroughly sampled by the Producers Mining Co. A copy of their assays, supplied by Mr. Kane, is attached.

Table 4. - Producers Mining Co. samples from Jim Kane mine

| No. | Description | Width, feet | Ounces Au | Ounces Ag | Percent Pb | Percent Zn |
|---|---|---|---|---|---|---|
| 2801 | Dump at incline shaft.................... | - | 0.01 | 1.70 | 3.07 | 5.80 |
| 2802 | Dump at 30 foot crosscut tunnel.......... | - | .02 | 1.40 | 5.40 | 6.60 |
| 2803 | Dump at 70 foot crosscut tunnel.......... | - | .01 | 1.00 | 4.60 | 2.70 |
| 2804 | Mill dump at middle tunnel............... | - | .01 | 0.60 | 3.20 | 1.10 |
| 2805 | Grab of high-grade from dump............. | - | .04 | 7.50 | 59.30 | 3.60 |
| 2806 | Face of north drift from stope........... | 3.0 | .02 | 2.70 | 1.56 | 1.20 |
| 2807 | Cut north drift from stope, middle tunnel | 4.0 | .005 | Trace | Trace | .60 |
| 2808 | do.................. | 4.0 | .01 | .90 | 0.25 | 1.15 |
| 2809 | do.................. | 5.0 | .01 | .90 | 3.54 | .80 |
| 2810 | do.................. | 5.0 | .01 | 3.90 | 2.25 | 1.30 |
| 2811 | do.................. | 8.0 | .03 | 1.30 | 6.00 | 1.40 |
| 2812 | Cut sample stope, north end hanging wall. | 5.0 | .04 | 29.40 | 3.65 | 1.30 |
| 2813 | Cut sample stope......................... | 6.0 | .01 | .70 | 2.10 | .80 |
| 2814 | Cut sample stope, footwall............... | 3.0 | .01 | 1.30 | 5.80 | 3.80 |
| 2815 | do.................. | 4.5 | .005 | .50 | 1.30 | 1.00 |
| 2816 | do.................. | 3.0 | .01 | 2.40 | 10.30 | 1.80 |
| 2817 | do.................. | 4.0 | .02 | 1.00 | 3.55 | 2.60 |
| 2818 | do.................. | 4.5 | .01 | 1.50 | 8.10 | 3.10 |
| 2819 | do.................. | 5.5 | .01 | 1.30 | 7.65 | .70 |
| 2820 | do.................. |  | .005 | .40 | 0.55 | .50 |
| 2821 | do.................. | 4.5 | .02 | .30 | Trace | 1.00 |
| 2822 | Cut sample stope, hanging wall........... | 4.0 | .08 | 6.10 | 5.50 | 4.25 |
| 2823 | Cut corner south drift from stope........ | 3.5 | .02 | 2.30 | 11.35 | 2.90 |
| 2824 | Cut at corner E. side S. drift 4 ft. S. of manway................ | 5.5 | .03 | 3.80 | 7.80 | 1.90 |
| 2825 | Cut in raise in hanging wall............. | 2.0 | .01 | .20 | 3.00 | .90 |
| 2826 | Below 2825............................... | 2.0 | .01 | .50 | 2.50 | 1.20 |
| 2827 | Below 2826............................... | 3.0 | .04 | 4.30 | 13.60 | 3.80 |
| 2828 | Cut 10 feet south of 2824................ | 5.0 | .02 | 1.10 | 1.80 | 2.50 |
| 2829 | Cut 10 feet south of 2828................ | 3.0 | .02 | 2.30 | 0.25 | .40 |
| 2830 | Cut at face south drift.................. | 2.0 | .02 | 2.00 | 5.75 | 1.00 |
| 2831 | Grab from muck pile at face.............. |  | .01 | .90 | Trace | .50 |
| 2832 | Grab from pile in stope.................. |  | .04 | 8.80 | 17.90 | 3.90 |
| 2833 | No. 1 underhand middle tunnel 30 ft. from portal.............................. | 3.5 | .01 | .80 | 5.50 | 1.80 |
| 2834 | No. 1 underhand middle tunnel 30 ft. from portal.............................. | 4.0 | .01 | .40 | 3.60 | 1.30 |
| 2835 | No. 2 underhand, 60 feet from portal..... | 1.3 | .02 | 1.70 | 1.65 | 1.90 |
| 2836 | do.................. | 3.0 | .02 | 1.60 | 4.60 | 1.00 |
| 2837 | Cut in bottom No. 1 drift south middle tunnel.............................. | 5.0 | .01 | .20 | 1.40 | 2.50 |
| 2838 | Cut at No. 1 chute, middle tunnel........ | 9.5 | .01 | 2.00 | Trace | .70 |
| 2839 | Cut face of 30 foot crosscut tunnel...... | 2.3 | .02 | 3.90 | 15.65 | 7.80 |
| 2840 | Cut incline shaft on pillar.............. | 3.0 | .01 | 1.00 | 4.80 | 11.20 |
| 2841 | Cut from north incline shaft............. | 2.5 | .01 | 2.00 | 14.60 | 6.70 |
| 2842 | Chip from outcrop south of middle tunnel. | 2.5 | .01 | Trace | Trace | 1.70 |

Table 4. - Producers Mining Co. samples from Jim Kane mine (continued)

| No. | Description | Width, feet | Ounces | | Percent | |
|---|---|---|---|---|---|---|
| | | | Au | Ag | Pb | Zn |
| 2843 | Cut from incline raise.................. | 4.3 | 0.02 | 2.60 | 4.75 | 4.00 |
| 2844 | do.................. | 3.0 | .01 | .80 | 4.30 | 5.40 |
| 2845 | Cut from incline raise, north side....... | 4.5 | .01 | 1.10 | 11.70 | 5.30 |
| 2846 | Cut from incline raise F. W. ............ | 2.0 | .02 | 2.50 | 10.10 | 8.60 |
| 2847 | Cut from tunnel 5,...................... | 7.0 | .01 | .20 | Trace | 2.50 |
| 2848 | do...................... | 5.0 | .01 | .30 | do. | 1.40 |
| 2849 | Grab from dump tunnel 5................. | | .01 | .20 | do. | 1.10 |
| 2850 | Cut incline raise above 2846............ | 4.0 | .01 | .30 | 2.30 | 1.20 |
| 2851 | Cut incline raise above 2850............ | 2.0 | .005 | .10 | .50 | 2.30 |
| 2852 | Cut hanging wall 5 feet south 2851...... | 2.0 | .01 | 2.40 | 16.60 | 5.10 |
| 2853 | Cut incline raise 10 feet 2843.......... | 3.2 | .01 | 1.00 | 4.20 | 4.40 |
| 2854 | Cut middle tunnel St. 15, north corner... | 4.0 | .01 | .70 | 3.80 | Trace |
| 2855 | Cut middle tunnel St. 15, south corner... | 3.5 | .01 | .70 | 2.10 | 0.70 |
| 2856 | Cut south drift 12 feet south of st. 15.. | 3.0 | .01 | .90 | 5.80 | Trace |
| 2857 | Cut south drift 35 feet south of st. 15.. | 4.5 | .02 | 3.30 | Trace | do. |
| 2858 | Cut south drift 40 feet south of st. 15.. | 4.2 | .02 | 4.50 | 2.00 | 0.60 |
| 2859 | Cut middle tunnel st. 16, corner crosscut | 2.5 | .02 | 3.80 | 4.80 | 3.80 |
| 2860 | Chip from boulders tunnel #5............ | | .005 | Trace | Trace | Trace |
| 2861 | Cut, face of open cut below tunnel #5.... | 2.3 | .02 | 20.30 | 3.60 | 3.70 |
| 2862 | Cut, outcrop below Kanes house........... | 2.5 | .005 | .10 | Trace | 2.90 |
| 2863 | Car sample from #1 chute................ | - | .01 | 1.60 | 10.70 | .50 |
| 2864 | Car sample from #2 chute................ | - | .01 | 3.10 | 17.10 | 4.20 |
| 2865 | Cut, upper north tunnel.................. | 3.0 | .01 | 1.80 | 7.20 | 2.40 |
| 2866 | do.................. | 3.0 | .01 | 1.60 | 9.60 | 5.50 |
| 2867 | do.................. | 4.3 | .01 | 3.60 | 6.80 | 4.20 |
| 2868 | do.................. | 3.5 | .01 | 1.50 | 4.00 | 7.20 |
| 2869 | Cut, pit 300 feet north upper tunnel..... | 3.0 | .005 | Trace | Trace | 1.40 |
| 2870 | Grab dump on Silver Queen claim.......... | - | .01 | 3.90 | 0.10 | 1.00 |

These assays were copied from a sheet furnished by Jim Kane, who stated that they were copies of the samples taken and assayed by the Producers Mining Co.

Seven check samples were cut in the main stope. These agreed fairly closely with the Producers Mining Co. samples.

| No. | Location | Description | Length feet | Assays Percent Pb | Zn | Cu | Ounces Au | Ag |
|---|---|---|---|---|---|---|---|---|
| 2844 | Stope drift, north breast | Altered granite and schist, some sulfide | 4.0 | 1.4 | 0.2 | 0.02 | Trace | 0.70 |
| 2845 | Stope drift, 10 ft. from N. breast.............. | do. | 5.0 | .2 | .2 | .02 | do. | .20 |
| 2846 | Stope drift, 20 ft. from N. breast.............. | do. | 5.3 | 2.4 | .2 | .02 | do. | .60 |
| 2847 | Stope drift, 30 ft. from N. breast.............. | do. | 5.1 | 2.8 | .1 | .05 | 0.005 | 1.40 |
| 2848 | Stope drift, 40 ft. from N. breast.............. | do. | 5.2 | 6.3 | .3 | .05 | Trace | 1.35 |
| 2849 | Stope drift, 50 ft. from N. breast.............. | do. | 6.5 | 7.3 | 1.8 | .04 | 0.005 | 1.30 |
| 2850 | Stope, northwest side.... | do. | 6.5 | .1 | .4 | .02 | Trace | .15 |

## CHICAGO GROUP

The Chicago group of four claims is situated on the north side of Cerbat Canyon, about 12 miles by road south of Chloride. The group is owned by J. A. Bell of Summerton, Ariz., and B. Ableman of Chloride.

There are a number of short tunnels, shallow shafts, and pits, all on oxidized outcrops of veins. One sample of oxidized vein material was cut at the bottom of a 30-foot shaft. The sample, taken over 2.5 feet, assayed 0.4 percent lead, 0.2 percent zinc, 0.06 percent copper, 1.9 ounces per ton silver, and a trace of gold.

## CERBAT MINE

### Location, Accessibility, and Ownership

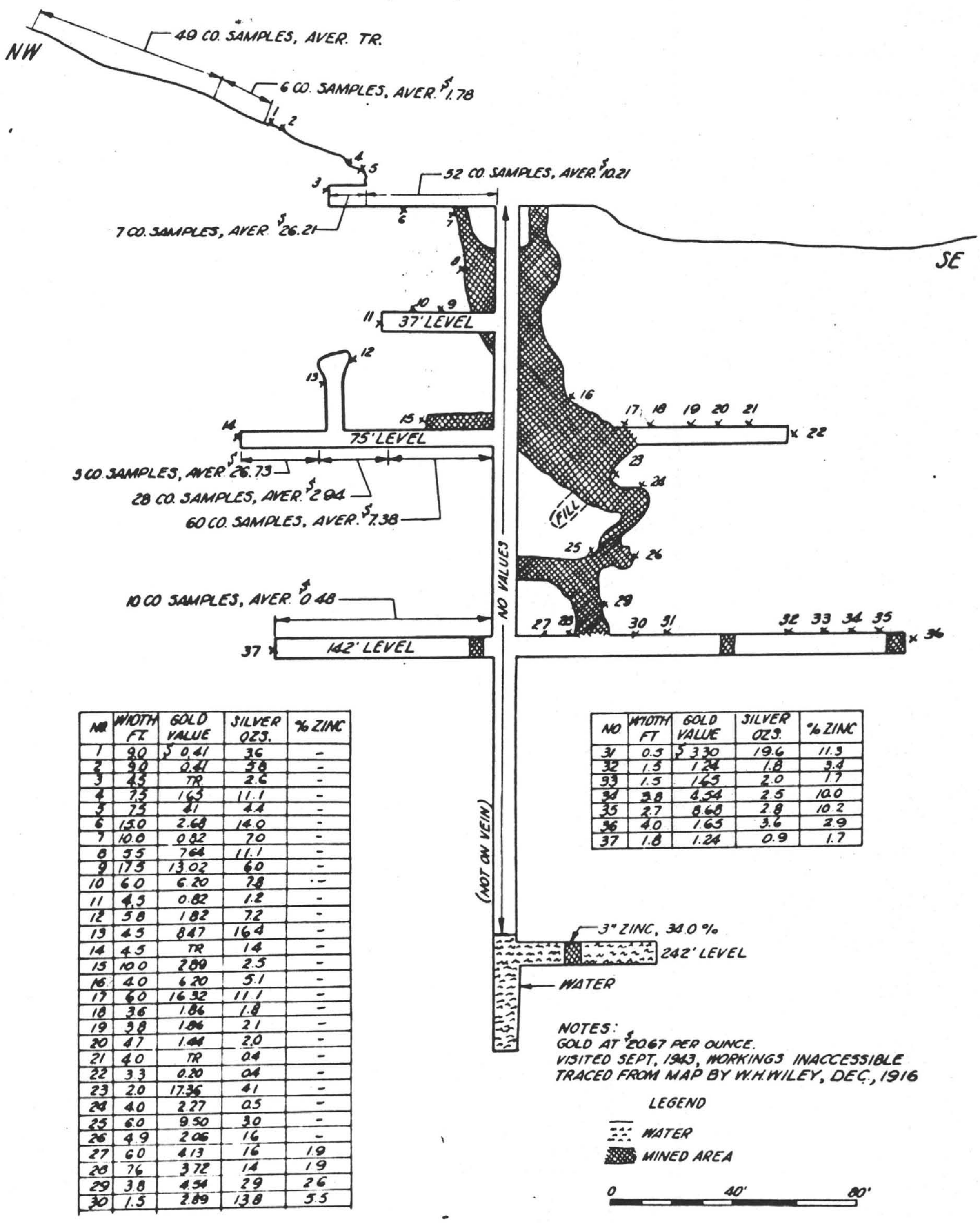
This property is on a western spur of the Cerbat Range north of Kingman and south of Chloride. The mine is reached by turning to the east off paved U. S. Highway 93, 7.7 miles south of Chloride and following a dirt road 3.7 miles, and then turning left on a branch road that leads to the Cerbat mine about 1 mile north. The last mile of the road is impassable.

There are five claims in the group, owned jointly by F. A. Morrison, of Kingman, who is in charge of the property, and the Pelton brothers. Three of the claims are patented and two are unpatented.

### History

The property was worked intermittently during the period 1869 to 1906 for gold and silver. It was credited with a production of $200,000 in gold and $50,000 in silver.16/ The mine was acquired by the present owners in

16/ Arizona Bureau of Mines, Arizona Metal Production: Bull. 140. ser. 19.




| NO. | WIDTH FT. | GOLD VALUE | SILVER OZS. | % ZINC |
|---|---|---|---|---|
| 1 | 9.0 | $ 0.41 | 3.6 | - |
| 2 | 9.0 | 0.41 | 5.8 | - |
| 3 | 4.5 | TR | 2.6 | - |
| 4 | 7.5 | 1.65 | 11.1 | - |
| 5 | 7.5 | .41 | 4.4 | - |
| 6 | 15.0 | 2.68 | 14.0 | - |
| 7 | 10.0 | 0.82 | 7.0 | - |
| 8 | 5.5 | 7.64 | 11.1 | - |
| 9 | 17.5 | 13.02 | 6.0 | - |
| 10 | 6.0 | 6.20 | 7.8 | - |
| 11 | 4.5 | 0.82 | 1.2 | - |
| 12 | 5.8 | 1.82 | 7.2 | - |
| 13 | 4.5 | 8.47 | 16.4 | - |
| 14 | 4.5 | TR | 1.4 | - |
| 15 | 10.0 | 2.89 | 2.5 | - |
| 16 | 4.0 | 6.20 | 5.1 | - |
| 17 | 6.0 | 16.32 | 11.1 | - |
| 18 | 3.6 | 1.86 | 1.8 | - |
| 19 | 3.8 | 1.86 | 2.1 | - |
| 20 | 4.7 | 1.44 | 2.0 | - |
| 21 | 4.0 | TR | 0.4 | - |
| 22 | 3.3 | 0.20 | 0.4 | - |
| 23 | 2.0 | 17.36 | 4.1 | - |
| 24 | 4.0 | 2.27 | 0.5 | - |
| 25 | 6.0 | 9.50 | 3.0 | - |
| 26 | 4.9 | 2.06 | 1.6 | - |
| 27 | 6.0 | 4.13 | 1.6 | 1.9 |
| 28 | 7.6 | 3.72 | 1.4 | 1.9 |
| 29 | 3.8 | 4.54 | 2.9 | 2.6 |
| 30 | 1.5 | 2.89 | 13.8 | 5.5 |

| NO. | WIDTH FT | GOLD VALUE | SILVER OZS. | % ZINC |
|---|---|---|---|---|
| 31 | 0.5 | $ 3.30 | 19.6 | 11.3 |
| 32 | 1.5 | 1.24 | 1.8 | 3.4 |
| 33 | 1.5 | 1.65 | 2.0 | 1.7 |
| 34 | 3.8 | 4.54 | 2.5 | 10.0 |
| 35 | 2.7 | 8.68 | 2.8 | 10.2 |
| 36 | 4.0 | 1.65 | 3.6 | 2.9 |
| 37 | 1.8 | 1.24 | 0.9 | 1.7 |

Figure 13. - Longitudinal elevation - Cerbat mine.

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

BULLETIN 340

# CONTRIBUTIONS TO ECONOMIC GEOLOGY 1907

Part I.—METALS AND NONMETALS, EXCEPT FUELS

C. W. HAYES AND WALDEMAR LINDGREN
GEOLOGISTS IN CHARGE



WASHINGTON
GOVERNMENT PRINTING OFFICE
1908

It is developed by crosscut tunnels and drifts, mostly within a vertical range of 100 feet. The country rock is sheared pre-Cambrian biotite granite. The vein has a width of about 40 feet, and dips steeply southwestward into the mountain. It seems to consist mainly of an altered and replaced crushed aplitic granite or rhyolite dike. The values favor the foot-wall side of the vein, being greatest near its contact with the granite. This mine produces gold-silver-lead ore. The last carload shipment made at the time of the writer's visit averaged: Gold 3.16 ounces and silver 8 ounces per ton, and lead 17.5 per cent.

*Rural and Buckeye mines.*—These two mines are located in the northeastern part of the Mineral Park district, at an elevation of about 5,000 feet. They are but a few hundred feet apart and are situated on the same vein, the Rural being on the west and the Buckeye on the east side of the same gulch. The principal developments in the Rural consist of a 200-foot shaft and about 100 feet of drift, and in the Buckeye of 750 feet of drift, toward the face of which the vein is faulted off to the north by a lateral throw of about 75 feet. The Rural shaft contains water. The vein in the Rural mine dips southward at angles of about 80°, but in the Buckeye it dips to the north at angles of about 70°. It is 2 to 8 feet thick and is associated with a dike of the aplitic granite intruded into the country rock, which is pre-Cambrian schist. It locally shows a 4-inch to 20-inch ore shoot, mostly iron and copper pyrites, with streaks of arsenopyrite, black oxide of manganese, and some chert and quartz, the quartz being more prominent in the Buckeye than in the Rural. The walls are generally frozen. The ore contains silver, gold, and copper, with the values high in gold.

*Golden Star mine.*—The Golden Star (formerly Lone Star) mine is located about a mile northeast of Mineral Park, on open ground. It produced rich sulphides of silver, containing gold and lead, from 1870 until 1902, when the ore seems to have fallen off in grade and become base and refractory. The mine is developed principally by a shaft 300 feet in depth and two levels, with 600 feet of drift on each level. The ore is stoped down to the 100-foot level. The vein dips steeply to the south. It is 2 to 4 feet in width, and the ore is all low grade. The total production is stated to be $375,000.

*Ark and San Antonio mines.*—The Ark mine, located about 2 miles southwest of Mineral Park at the west base of the mountains, is developed by a 250-foot shaft and three levels, comprising about 1,300 feet of workings. It produces considerable water. The vein, which is 5 or 6 feet in width, dips steeply to the northeast. The ore is of a sulphide character and contains gold, silver, and copper. It runs about 175 ounces of silver and 3.15 ounces of gold per ton. The production is about $150,000. Adjacent to the Ark mine is the San Antonio, which has produced $75,000.



### CERBAT DISTRICT.

*General outline.*—The Cerbat district, an area about 4 miles in diameter, is situated south of the Mineral Park district, in the foothills at an elevation of 3,500 to 5,000 feet, 3 miles east of the Arizona and Utah Railroad. It has produced more than $2,000,000. It is drained principally by Cerbat Wash, which leads westward into Sacramento Valley. The mines north of this wash are gold bearing; those to the south yield silver and lead. The principal mines are the Golden Gem, Vanderbilt, Champion, Oro Plata, Paymaster, Cerbat, New London, St. Louis, Flores, and Twins, the three first named being among the most important present producers.

*Golden Gem mine.*—The Golden Gem mine, located on Cerbat Wash, is developed principally by a 430-foot shaft and four levels comprising 1,200 feet of drift and stopes. The stoping is on the 130-foot level, and extends 166 feet horizontally and from 62 to 81 feet vertically. This mine yields considerable water. The vein dips steeply to the northeast. It ranges from 6 to 14 feet in width, and usually carries 2 to 6½ feet of pay ore running from $10 upward per ton. The values favor the foot wall. The gangue is quartz. The ore is gold ore and carries also silver, locally 60 ounces per ton, lead 5 to 6 per cent, antimony and zinc a trace, and some iron pyrites. The production to date is $190,000. A 40-ton mill is now turning out about $350 worth of concentrates a day from ore formerly left on the dump.

*Idaho mine.*—The Idaho mine adjoins the Golden Gem on the west, and the ore is similar to the Golden Gem ore. The mine has been worked in a small way since 1871, and the total production is reported to be about $200,000.

*Cerbat mine.*—The Cerbat mine, located about a mile northeast of the Golden Gem mine, is 200 feet in depth. The vein is 4 to 10 feet thick, and the total production is stated to be about $300,000 in gold and silver.

*Paymaster mine.*—In the Paymaster mine, about 1¼ miles northeast of the Golden Gem mine, the vein dips steeply to the north. The ore contains silver and gold, runs high in values, and carries much ruby silver. The production to date is said to be $200,000. Considerable water is found in this mine.

*Oro Plata mine.*—The Oro Plata mine, located about a mile northeast of the Paymaster mine, is 280 feet deep and is developed by about 7,000 feet of underground work. It produces considerable water. The pre-Cambrian country rock is here intruded by the aplitic granite. The ore values are chiefly in gold and sulphide of silver, with locally some lead. They run about $37 per ton. The total production is given as $500,000.

## STOCKTON HILL DISTRICT.

*General outline.*—The Stockton Hill district joins the Cerbat district on the east, being situated on the opposite slope of the mountains, about 10 miles north of Kingman. It is about 4 miles in diameter and ranges from 3,500 to 5,500 feet in elevation. It is generally rough, but the mines are all accessible by wagon roads, in the main of easy grade. The drainage issues eastward into Hualpai Valley. The principal camp is Stockton Hill, situated in the eastern part of the district. The veins in general strike northwestward. 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 '63.

*Banner Group mine.*—The Banner Group mine is situated near the center of the district. It is developed by more than 2,000 feet of underground work, including the "tunnel" or drift, which extends in 1,600 feet on the vein. The vein dips steeply to the northeast. It is 6 to 8 feet in width, and the ore shoot is 2 to 2½ feet thick and favors the foot-wall side. In some localities the ore consists of pure galena, but usually it contains gold, silver, zinc, iron, and copper, the gold in places amounting to several ounces per ton. The amount of zinc increases in the deeper north portion of the mine. 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 ore is shipped to the Needles smelter.

*Treasure Hill mine.*—The Treasure Hill mine is located in the foothills in the southeastern part of the district. It is developed by inclined shafts and drifts, and yields a large supply of good water. The veins, six in number, dip steeply to the northeast. They average about 5 feet in thickness at the surface and widen downward. They are associated with what seems to be a small stock of the aplitic granite, and the two next to it are now being worked. The ore favors the hanging wall and occurs in shoots 100 to 200 feet in extent, with intervening clay or talcose gouge and sulphides. It runs about 100 ounces of silver and $5 to $16 in gold per ton, and 7 to 10 per cent of lead. The total production is stated to be $100,000.

*Cupel mine.*—The Cupel mine is situated at Stockton Hill camp. It is now being reopened and an excellent 200-ton mill and plant of the Joplin type have just been installed. It is developed to a depth of 400 feet, principally by shafts, drifts, and stopes, and is said to yield about 25,000 gallons of water per day. It is located on three veins, whose general trend is northerly. The ore in general contains ruby and horn silver, together with black sulphide of silver, but in some places is rich in high-grade galena and carries about $5 per ton in gold. About 2,000 tons of ore said to run from $6 to $7 per ton lie on the dump. The production to date is reported to be about $500,000.



*Prince George mine.*—The Prince George mine, located about one-fourth mile southeast of the Cupel mine, is developed by a 180-foot shaft and drifts, and is said to yield about 2,000 gallons of water a day. The vein dips steeply to the north and is about 12 feet thick. The total production is about $100,000.

*De la Fontaine mine.*—The De la Fontaine mine, located at the west side of the district, on the crest of the range, is 400 feet deep, and comprises about 1,400 feet of drift. The vein is 7 to 10 feet in width, and dips steeply to the north. The ore runs about 35 per cent in lead and zinc, and contains some gold. Good ore bodies, 2 to 4 feet thick and of considerable extent, are blocked out in the lower 300 feet of the mine.

*'63 mine.*—The '63 mine, located in the southern part of the district, is 200 feet deep and is stated to have produced a total of $500,000, mostly in rich silver ore.

*Little Chief mine.*—The Little Chief mine, located one-fourth mile west of Stockton Hill camp, is about 100 feet deep and contains about 1,000 feet of underground work. The vein, supposed to be one of the veins of the Treasure Hill mine already described, dips steeply to the northeast. The production, amounting to many thousand dollars, is all shipping ore, averaging in silver about 350 ounces and in gold 5 to 10 ounces per ton, with 8 to [illegible] per cent of lead.

*C. O. D. mine.*—The C. O. D. mine, located 2½ miles north of Stockton Hill camp, in the upper part of C. O. D. Gulch, is developed by a shaft 400 feet deep, drifts, and stopes, on and between two main and two subordinate levels, aggregating in all about 2,500 feet of underground work. The principal surface equipments consist of a 50-ton concentrating mill and engines. The vein dips steeply northward, and is about 7 feet thick. The ore, whose principal value is in silver, runs about as follows: Silver, 160 ounces per ton; gold, 2 ounces per ton; lead, 12 per cent; with some zinc and a little copper. Except the low-grade ore, it is mostly worked out for a distance of about 400 feet on either side of the main shaft, beyond which good ore is reported. The mine closed down late in 1904 and is now full of water. The total production is reported and in part verified by smelter return sheets to be $1,300,000, that of silver alone amounting to about $1,000,000.

## GOLD BASIN DISTRICT.

The Gold Basin district is situated in the eastern part of the White Hills, in the Gold Basin mining district. It extends over a hilly area about 6 miles in diameter, sloping and draining to Hualpai Wash on the east, and ranges from 2,900 to 5,000 feet in elevation. The water

5

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# GEOLOGICAL INVESTIGATION OF THE CHICO MINES AREA
# CERBAT MOUNTAINS
# MOHAVE CO. ARIZONA

Kevin Michael Kenney

2 AUGUST 1976

## VEIN SYSTEMS AND RELATED STRUCTURES ON THE CHICO MINE SITE:

Several large linear structures referred to as dikes and/or veins, cross cut the property. The most noticeable of these is the Bronco Dike. It is several thousand feet long, extending from the north to southern boundary of the claims, and continuing on to an intersection with a dike swarm located in Todd basin. Its thickness variesfrom 50 to 70 feet and it dips flatly (about 40 degrees SW) with an approximate N-20 W strike. It cuts all lithologic units present in the mine area. The dike is composed of a dioritic to diabasic rock that is banded, with an aphanitic texture. The periphery is composed of a silicified gouge like material that resembles chert or quartzite and has heavy manganese staining. Slikenside and shearing evidence is present. Evidence of mineralization in the dike come from gossan caps, in place mineralization underground and the extent of underground mining carried out on the dike.

The next most notable linear structures present are two presummeably non-mineral dikes that are located on either side of the Mint Mine on Stockton Hill. One of these dikes, the northern most is an aplite body approximatley 4 feet wide and has pegmatite veinlets cutting it. A granite porphry dike to the south of the Mint ranges to 10 feet in width and has strong relief. This dike appears to be non-mineralizing (from surface study). Both of these bodies project to an intersection with the Bronco dike.

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The last of the structures that are noticeable are the veins. Typically they are characterized by low relief,are capped by manganiferous stained gossans and are relatively hard to trace on the surface. Exploration cuts are the best method for locating these banded quartz gossans.

DESCRIPTION OF UNDERGROUND WORKINGS:

NAME: Bronco Dike Tunnel        Page 4

LOCATION: East end of Scotty #1 extension. On the dikein the wash that descends from the Cashier workings It is due north of the True Blue and adjacent. to the mill site.

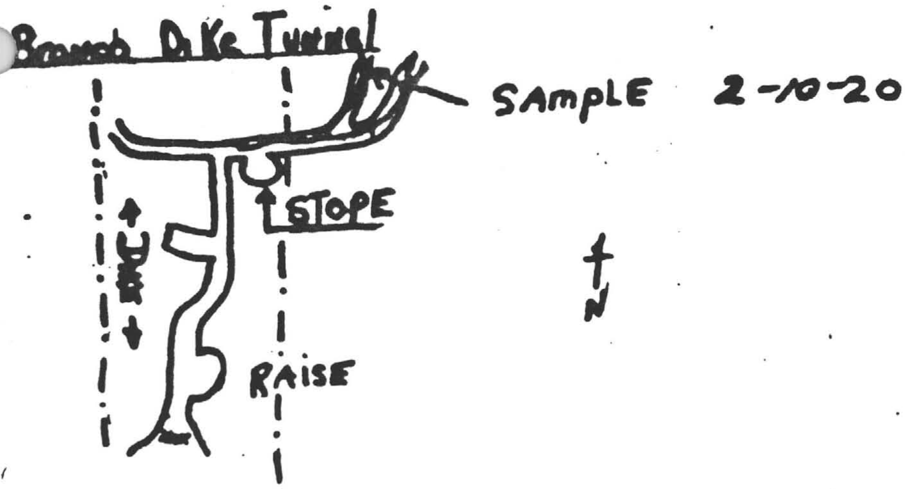
MINE DESCRIPTION: Present condition- entrance partially blocked by wash debris. Tunnel is partially blocked by mud deposit and rear of mine under 2 feet of water but accessable. Wall conditions are stable but rotten rock is abundant The main workings follow a vein that trends to the nw-se. The east part of the vein splits into two segments and the vein is 4 to 5 inches wide mineralized by quartz, galena, sphalerite and argentite. Assay # 2-10-20 reports 2.912 oz AU and 3.89 oz Ag. There is one small stope, track is in place and there is no timbering.

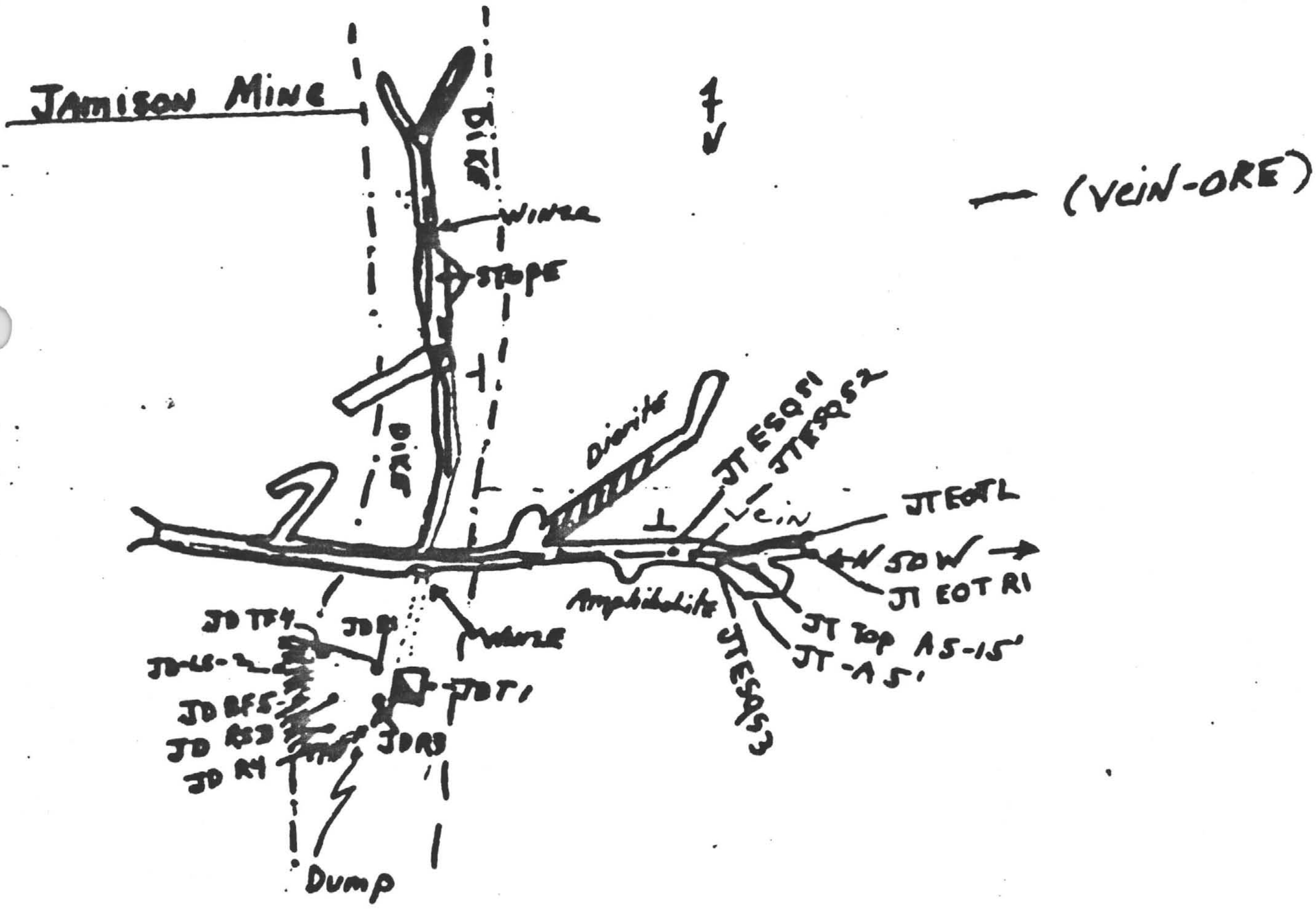
Across the wash from the above workings there is an inclined shaft that is flooded presently. This is alsoon the Scotty Extension claim This shaft is collared on the Bronco dike , heads east under the dike and it is rumored that good values were taken from a "white gouge zone" several 10's of feet below the surface. A similar geuge zone is present east of the shaft in the wash. The shaft was pumped down 20 feet in January of '76 and it took 2 days for it to reach its present level. There is track in the shaft and the headframe is down.

NAME: Jamison Mine - Golden Elsebeth Tunnel page 4

LOCATION: Shaft and tunnel entranxe located on the Mammoth #1 lede mining claim adjacent to the south boundary of the Scotty Extension #2 and on the east boundary of the True Blue patented claim and adjacent to the mill site

MINE DESCRIPTION; Both the shaft and the tunnel are located on veins that appear to cross cut the dike. The Elsebeth tunnel intersects the upper workings of the Jamison mine. OLD WORKINGS: Most of the development work done in the Jamison were done in the dike its self. The shaft was deepened to 300 feet by Goetz and some ore was produced, mainly chalcopyrite, pyrite, galena and sphalerite. Presently the bottom of the shaft is flooded. Fairly extensive workings are noted but vein width is not great, generally not more than3 to 4 feet. and the lower workings are inaccessable. No estimate can be made at this time as to the tonnages that have been removed. In the quartz veins present in the dike chalcopyrite, galena and sphalerite constitute the bulk of the mineralization.


Branch Dike Tunnel
SAMPLE 2-10-20
STOPE
DIKE
RAISE
N


JAMISON MINE
N
DIKE
Winze
STOPE
DIKE
Diorite
JT ESQS1
JT ESQS2
Vein
JTEOTL
N 50 W
JT EOT R1
JT Top AS-15'
JT-AS'
JTESQS3
Amphibolite
Winze
JD TF4
JD R1
JD-LS-2
JD BFS
JD RS3
JD R4
JD R3
JDT1
Dump
— (VEIN-ORE)

New workings in the Jamison consist of two tunnels that were driven by Geetz. The main extension is centered on a crosscutting vein that intersects the dike. No stoping was done here. There does not seem to be any workable width to the vein, it just pinches down to several inches. The vein dips to the nw steeply and the gouge zone is several (10feet) wide. Some copper mineralization is noted, but generally the vein is weak. The other tunnel is cutting good solid diorite, On first glance the walls seem barren and no actual vein is followed. The rock is highly sheared or jointed and there is disseminated mineralization on these fracture surfaces. This material closely approaches porphry type mineralization..

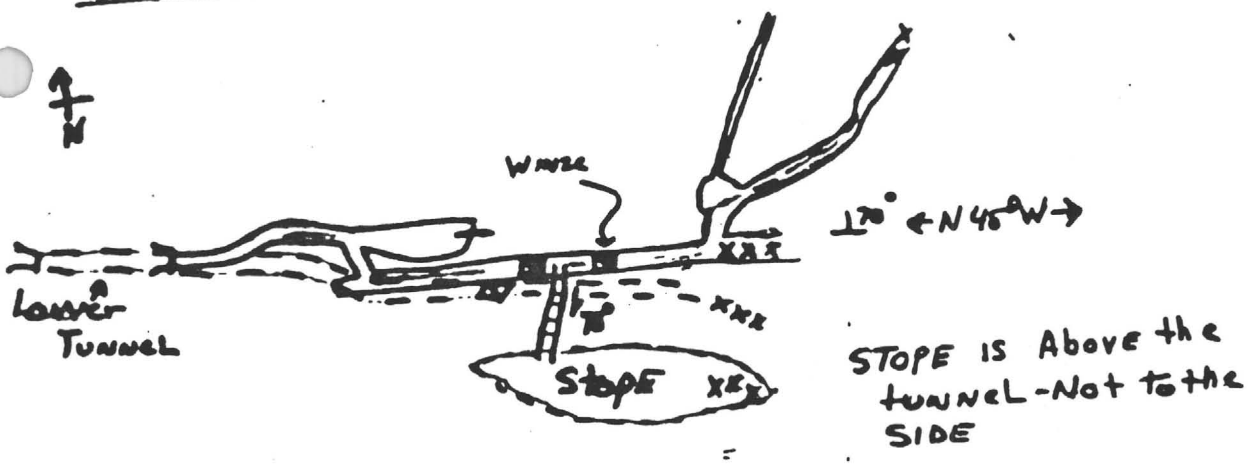
Two more tunnels and several pits explore the "Jamison vein" on the surface above the shaft collar. No work was done on these due to poor condition.

NAME: CASHIER MINE

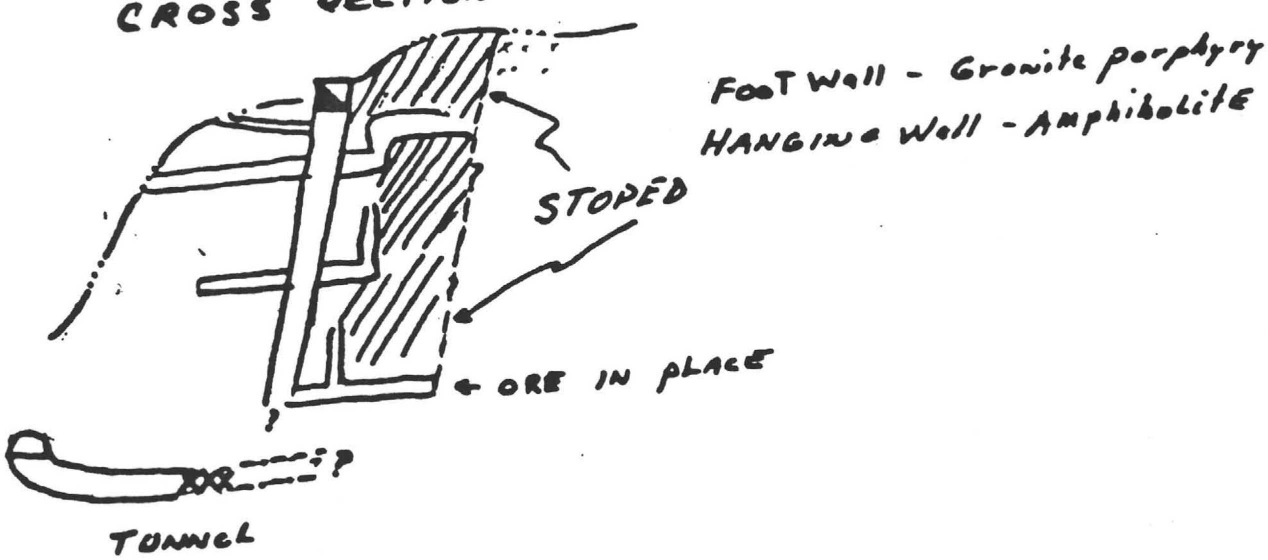
LOCATION: On the cashier claim which is a north-south trending parcel. It abuts the Scotty Extension #2 and mammoth #1. It is located in the wash up the hill from the mill site.

MINE DESCRIPTION: The Ableman tunnel is located in the wash described above. It is caved in 40 feet from the portal. The cave in is man caused, not natural. The rear of the caved zone is flooded with 8 feet of water. A shaft further up the wash is collared on the Cashier vein, is eighty feet deep and is reported have good ore in it (F.J. Denton ). Refer to the report

## MINT MINE




## Little Boy Mine/Shaft Cross Section



section is flooded but passable. One stope is developed by several raises and there is at least one winze that is flooded. Take caution when exploring this working--very DANGEROUS.

The upper tunnel is in good condition, no flooding. The walls are in good shape for being in the amphibolite. Again the quartz vein is present, it dips steeply to the nw almost vertically. one fair sized stope is accessable by ladder. Here the vein swells to 4 feet across. This corresponds to the stope in the lower tunnel. A winze in the floor leads to the lower workings, and timbering on the floor and below is visible, IE. part of the tunnel floor is wood. The full extent of the old workings are not available due to caving ground and bad timbering. Goetz cleaned out the back of the tunnel and replaced some ofthe timbers but for the most part it is not passable.. The quartz vein is mineralized by good values in argentite, galena, sphalerite, native silver etc. Native silver has been found by the writer in the back sections of the workings along with argentiferous pseudomorphs of pyrite. It is evident underground that there is either a horse-tailing of the vein or an intersecting vein cuts the mint, due to the perpendicularity of some of the workings. At

... breccia zone is present

the '98' vein that is seen on the surface and penetrated by the '98' shaft. The mint vein merits rig erous exploration by mapping and drilling and geophysics.

NAME: '98' shaft

LOCATION: On the '98' claim which is situated due north of of the patented little boy claim.

MINE DESCRIPTION: The mine is a simple verticle shaft with two horizontal tunnels developed inthe plane of the vein. There is oxide ore in place in the tunnels. This material is greenish, resembling malachite but it is actually silver bromide. Little material has been removed and the bottom of the shaft is flooded .

NAME: LITTLE BOY PATENTED CLAIM

LOCATION: The claim is located to the right of a road that leads to the 98 shaft and to the Goetz shaft.

MINE DESCRIPTION: The mine is collared on the little boy vein. A head frame is in place and ladders descend to a depth of about 200 feet where they break off. The area to the west of the ladder has been stoped bythe shrinkage method and only in several places do outcrops of in place ore occur. The vein is situated on the contact of a granite porphry dike and amphibolite. Where seen the vein is clean with little gouge and was 2.5 feet wide. The vein is a quartz body mineralized by banded layers of heavy sphalerite and galena ad some chalcopyrite. The vein where seen stood clean by its self and could be recovered easily with little waste. All workings were developed in the competent porphry dike . Considerable ore was taken from this mine but much remains due to that mining was halted at the claim boundary. In two tunnels ore was present on working faces.. The vein stands almost vertical with a dip of 70 degrees,W. The workings are access,ble, but the ladders break off about 75 to 100 feet from the bottom and the lower tunnels are dangerous to get to. Safety line is required.

The surface geology of the little boy claim group, including the '98' claim and the Goetz shaft can be character-ized by an area of rocky terrain consisting of PC amphibolites cross cut by several mineralized veins and at least three dikes. One dike is a porphry body described above. The other 2 are those noted in the mint area.. The Goetz shaft is collared in an extension of the 98 vein and is only 30 ft. deep. Good values from oxide ore reported in assay . A fair amount of shallow drilling was done on the 98 system and on projections of the mint and little boy, but these holes were to shallow and at bad angles and show relatively nothing. A good amount of dozer trenching and stripping has been done on the 98 system and it readily tracable for 2000 ft. on the surface. Good gossan is present and assays show fair silver values for surface material and gold is higher here due to mechanical accumulation by weathering. A fair tonnage of ore , as oxide could be produced by stripping the vein surface carefully.

West of the Little Boy shaft gossan is exposed in road cuts and an area has been bladed off to expose good gossan. The quartz vein here 3 feet wide and has a possible projection towards the Mint structure.

North of the 98 system up in the little boy # 7 and #8 there is a very good possibility that at least two mineralized veins will be found. Here is the reasoning: The Alphavein runs a course that would put it off to the north of the #8 claim. There is a possibility that it could outcrop on the #8 claim. The cashier vein which runs thru a claim south of the Magnolia and Alpha, up thru a wash would logically outcrop on the little boy #7 claim. These two possible veins have not been explored by the writer, but should be done soon.

CONCLUSIONS:

The Mint vein and associated veins of the 98 and little boy groups are at present the best prospects for conducting any type of ore finding program. Detailed geologic mapping coupled with geophysics (EM ) to locate anomalies upon which drilling can be done is the logical approach.

The cashier vein system should be mapped out and possible intersections with the Bronco dike be studied for possible areas of ore deposition, likewise with the

Mint vein.

A careful study of the area east of the Bronco dike tunnel is in order because of the trend shown by the veins in the workings. A possible intersection was not probed by the DuPont drilling program.

This report concludes a three month study of the Chico Mine area conducted by the author. Surface and underground geology was noted while the primary task of gathering assay data was accomplished. Detailed work was not possible due to lack of equipment and qualified help.

Respectfully submitted,

Kevin M Kenney

2 AUGUST 1976

Kevin Michael Kenney

A.T. B.T. Chemical Engineering

B.S. Geology

M.S. Metallurgical Engr. (in Progress)

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Richard E. Mieritz
MINING CONSULTANT

GEOLOGY
EXPLORATION
EVALUATION
FEASIBILITY
OPERATION

February 21, 1967

Mr. Charles Goetz
Charles Goetz Mining
P. O. Box 2228
Phoenix, Arizona, 85001

Dear Mr. Goetz:

At your request through Mr. Alex Prohoroff and accompanied by him on February 18 and 19, 1967, I briefly examined the Chico group of lode claims south of the Duval Sulphur copper operation near Chloride, Mohave County, Arizona.

Mr. Prohoroff explained the purpose of the examination as being to provide you my ernstwhile and candid opinion of the property and if it was of sufficient "merit"; then to provide you my candid recommendations as to project procedure in the immediate future.

Mr. Roy Montague very cooperatively accompanied Mr. Prohoroff and myself over the property as well as pointing out many of the mineralized structures and providing the writer with many facts which he has gained from prospecting and working the property for a five year period. I found Mr. Montagues' facts and remarks very accurate and is a capable man.

The brief examination included observing all the accessible underground workings of the Jamison structure currently being drift developed about 80 feet lower in elevation than the main Adit level and a very fast "look-see" of most all other vein structure outcroppings within the claimed area.

On the basis of what was observed in the underground workings and surface exposures plus facts provided by Mr. Montague, it is my honest opinion that the property hosts well developed strong structures containing strong to moderate copper, zinc, lead, gold and silver mineralization. I also strongly opinionate that the property poessesses the potential of a large mass containing complex low grade mineralization as copper, zinc, lead, gold and silver.

Regardless of the type and mode of mineralization and a desire or thought to "operate" as soon as possible, exploration and development of the "veins" or low grade "mass" are a pre-requisite to <u>any</u> well planned profitable operation, that is to say, before any mining and milling operation could be planned to provide a reasonable profit and return of capital investment required for such an operation whether it be underground mining or open pit mining.

Without going into all ramifications of geologic rock types, structural features, etc, as I am sure my predecessors have fully described, let me say that major mineralized structural features within the property generally strike N. 30° W. or S. 30° E. with very steep dips and other structures strike about North-South with flatter dips, usually to the west. These mineralized structures as exposed on the surface appear to be about 200 feet, or less, apart. The area can therefor be considered as one of moderately, majorly fracture patterned and was therefor very receptive to mineralization. An observation of particular importance is the fact that disseminated copper, zinc and lead mineralization is exposed in some of the Jamison underground workings. The degree and extent of such mineralization is difficult to evaluate with the limited amount of workings available.

In general, I am of the opinion that this property parallels to a great extent the geologic and structural features as the Duval property to the north.

The Chico property could produce at some future date either by (1) underground mining and milling of the strong, highly mineralized structures with limited small daily production, or (2) open pit mining and milling of low metallic content material but with large daily tonnage. In either case, adequate exploration and development must be done before high investments are made.

Exploration and development to assure adequate ore reserves (at least two years supply for underground mining) must be proved. Such exploration and development work by underground methods is slow and costly. I can not recommend this route at the moment.

The observance of disseminated mineralization in the Jamison workings suggests the potential presence of a low grade mineralized mass in this vicinity. This expression of disseminated mineralization is not however visible on the surface. None-the-less, its presence is of sufficient importance that it must be explored.

The dissemination is no doubt a result of and controlled by the major fissure or structural features in the area. Since most major structures in the area are very steep dipping in character, it is best to "explore" these and their intervening areas by some means of crosscutting at as near a right angle as possible, both strike-wise and dip-wise. Such work must originate in the area of known mineralization, weak or strong, and in this case it is the exposure of dissemination on the Adit and 80 foot levels of the Jamison workings.

Diamond drilling is by far the most rapid and less expensive as compared to underground cross-cutting exploration. To this end I therefor recommend to you the following:

(1) Diamond drill two holes from an underground station near the face of the 80 foot level.
(2) The length of these holes should be 500 feet plus and directed approximately N. 75° E., collared on the east wall of the drift while the second hole should be directed approximately S. 45° W. and collared in the west wall of the drift.
(3) Both holes should be drilled at a -15° from the horizontal. The bottom of a 500 foot hole will then be approximately 130 feet below the elevation of the present 80 foot level. Drilling in the directions indicated in (2) will place the bottom of the holes approximately 100 feet ahead of the present face of the 80 foot level.
(4) Holes should be drilled BX and AX size if possible, if not, then AX and EX size.

Such drilling will then be exploring the area beneath the disseminated mineralization observed on the Adit level beyond the winze servicing the 80 foot level as well as cross-cutting an vein structures within the 500 foot distance.

If this exploration shows encouraging results it would be advantageous to move your surface diamond drill onto the property and commence an energetic, well planned, grid type, vertical hole program approaching 15 to 20,000 fect of drilling.

The initial underground drill program recommended should be contracted since time is of the essence and such program would cost approximately $10,000.00 plus including a contract price, sampling and assaying and professional supervision.

Taking of samples in the mine at this time ia an expense which could not be justified, however, two samples were taken as follows: (1) material representing the mineralized rock (about 80 tons) Mr. Montague removed from the 80 foot level and has stock piled near the portal and (2) cuttings from a 20 foot long drill hole Mr. Montague drilled into the east wall about 50 feet from the present face on the 80 foot level. The results of these assays as completed by Valley Assay Office in Tempe are as follows: (next page)

7/1/

| | Oz. Au | Oz. Ag. | % Cu | % Zn | % Pb. |
|---|---|---|---|---|---|
| Samp. 1 (stockpile) | 0.08 | 16.8 | 6.6 | 0.10 | 0.05 |
| Samp. 2 (cuttings) | Tr | 0.10 | Nil | Nil | Nil. |

No disseminations were observed near the collar of the 20 foot drill hole which sample No. 2 represents. Washing of the cuttings did however show some pyrite mineralization.

It is hoped the above will provide you with adequate information on how to further proceed with the Chico project. If you have any questions, please call me.

Respectfully submitted,

R. E. Mieritz

R. E. Mieritz, P. E.
Mining Consultant.

Registered Professional Engineer (Mining)
Certificate Expires
RICHARD E. MIERITZ
DEC. 31, 1967
ARIZONA, U.S.A.

R E P O R T

ON THE PROGRESS AT THE JEMISON MINES

CERBAT MOUNTAINS. MOHAVE COUNTY. ARIZ.

BY

W.W.LYTZEN. E. M.

SEPTEMBER 18, 1917,

May 27, 1957

JEMISON MINES COMPANY MOHAVE COUNTY

This property idle.

See: Nighthawk Mine (file) Mohave - article from Mohave County Miner dated 9/5/74

MARK GEMMILL

Lauzier Wolcott Company,
51 E. Broadway,
Butte, Montana.

Gentlemen:

This report is a continuation of my report on the same property submitted July 3, 1917.

PROGRESS:

The shaft has been sunk from 82 ' below the tunnel (100' level) to the 300' level, a distance of 108 feet. It has a uniform dip of 78 degrees to the S.W. and is along the foot wall of the vein in granite porphyry. The shaft is 290' below the collar.

The 100' level, or the main tunnel level has been advanced 110' to a total of 510' S.E. of the Broncho Dyke. A crosscut N.E. was run 20', 205' S. E. of the shaft.

The 200' level has been drifted on 75' and the vein is 15' S.W. of the shaft.

At the 300' level the vein is crosscut at a distance of 16' S.W. of the shaft, and is drifted on 20'.

The reader is referred to the accompanying map for a better understanding of this progress and to the following part of this report.

Also an auxiliary air compressor of 125 Cu. ft. capacity has been added to the mechanical equipment.

A shipment of ore made in August (8/25/17) to the Consolidated Arizona Smelting Company, Humbolt, Ariz., ran $6.60 Gold; 19.40 oz. Silver; 4.67% Copper, which after deducting smelter settlements has a net value per ton of $37.93. Silver was paid for at 87.42¢; Copper at 24.92¢; Gold $19.00 per oz.

## GEOLOGY

That the vein is a true rock fracture I feel quite certain. It cuts both diabase and porphyritic rocks. That it is later than the diabase is shown by the fact that at the beginning of the vein on the underside of the rhyloite dyke it (the vein) has diabase for both walls.

The thickness is not definitely known on account of no openings at this point. The diabase wall rock is seamed with tiny veinlets of sulphides, most pyrite.

As the main tunnel (100' level) is followed southeasterly past the shaft the diabase is a mere shell, or casing for the vein and also forming varying amounts of vein filling, having been replaced by quartz and sulphides in part.

This diabase casing is quite thin as in places it is an easy matter to pick through to porphyritic rock.

At 305' S.E. of the Dyke no more diabase is found on the hanging wall side, but it continues as the foot, and a crosscut run in 20' N.E. still has diabase in the face showing a condition much thicker horizontally than that indicated in my first examination.

The diabase in this crosscut is slightly pyritized and contains small seams of sphalerite (zinc sulphide).

At 460' S. E. of the dyke, at the tunnel level, the diabase contact with the porphyry swings N. E. out of the tunnel and from here on the tunnel is within porphyry walls to the face.

At the time of my examination in June, the face of the tunnel was 400' E.E. of the dyke and oxidized vein quartz was just beginning to show itself. This oxidation has been present all along the vein up to the present face. A short shoot of ore about 20' long and 10 to 12 inches wide developed here which sampled 10" wide $0.80 gold; 31.52 oz. Silver, and 6.27% copper. Total value with copper at 18¢ and silver 65¢ of $43.85 and with 23½ and $1.00 prices, the total value is $60.80 per ton.

Beyond this both sulphides and quartz gradually pinch out and only a small clay seam is now in the face.

The porphyritic rock is roughly sheeted and dips to the N. E. from 70 to 80 degrees.

The vein conforms to this sheeted structure, as 25' back from the face a good wall of porphyritic rock with a clay quage has the same dip.

The change in dip makes it highly probable that this tunnel is on the same vein as the two upper tunnels are on (the vein containing the rich stope that was worked years ago by "Highgraders").

The relative position and dip correlates them very close. The present tunnel face is about 225' from the position of this stope, which is reported to have produced $50,000, and it is 220' underneath it, but there should be ore developed in the vein before that point is reached.

SHAFT, 200' and 300' LEVELS:

The shaft is being sunk in the foot wall of the vein in a granite porphyry rock. At the 200' level a brokenup condition was found where the vein was crosscut and large quantities of water had to be pumped beforethe water held in storage in the vein was drained off. There is evidence of movement along the foot wall and a cross fault throws the vein 2½' to the north.

The mineralization in this area is slight, but in the drift to the S. E. the vein is beginning to look very much better. It is about 5' wide and a 3.8' wide sample of friable quartz ran gold $4.40, silver 6.6 oz. and 1.53% copper.

The drift to be N. W. is also in a badly disturbed condition. A 3' sample of the back 12' N.W. of shaft ran gold $1.20; Silver 11.00 oz. and copper 2.30%, total value $16.63 with silver 65¢ and copper 18¢.

A sample of a 18" seam of sulphides on the hanging wall, 52' N.W. of the shaft ran gold $4.40, Silver 5.60 oz. and copper 0.48%. A composite of the 200' level samples ran only 1.90% zinc showing the inpoverishment in that metal at this level.

No.oxidation is visable on the 200' level. The vein has the strike and dip indicated by thework above on the 100' level. The country rock on the S.E. side of the shaft is granite porphyry. On the N.W. side on this level diabase is very prominent and forms both the hanging wall and part of the vein filling.

On the 300' level there are sulphides and quartz and decomposed porphyritic rock making up a vein for a width of 5', but pretty much scattered. A 10" seam on the hanging wall ran Gold $0.60; Silver 26 oz. copper 3.07% and zinc 2.37%. A 10" seam in the center of the vein ran gold $4.60, Silver 2.27 oz. a trace of copper, and 4.74% zinc.

These two 10" samples average gave gold $2.60, Silver 14.13 oz.; Copper 1.53%, zinc 3.55%. The total value exclusive of the zinc with silver at 65¢ and copper at 18¢ is $17.28 per ton, and with 23½¢ and $1.00 prices thevalue is $22.92 per ton.

The vein here is drifted on 20' and has the correct strike and dip as indicated above.

No diabase is visable yet, the granite porphyry being on both sides of the vein.

SUMMARY:

The development on the 200 and 300 foot levels has shown a strong continuous vein with ore averaging $17.00 per ton with silver at 65¢ and copper at 18¢. But there has to be much more drifting done, especially N. W. towards the Broncho Dyke.

On the 300' level it will be about 300' from the shaft. The vein structure is good. There has been sulphide mineralization and vein quartz deposited wherever the vein has been followed.

All the attendant geological features or conditions that have been responsible for the formation of nearly all ore deposits occupying fissures in igneous rocks are here.

First, the veins at the Jemison occupy fissures in a granite porphyry which is itself intrusive into an older granite gneise. This porphyry is in turn intruded by rhyolite and diabase dykes.

As result of the stresses accompanying these intrusions, and the repeated heating and cooling the fissures were formed. That the fissures tapped the reservoir from which these molten rocks came not only once but most likely twice seems to be the case.

That considerable sulphides were carried up these fissures by the "after-effects" of subsiding igneous activity is seen in the ore body of the tunnel level.

Conditions of rock associations are the same on the 100 and 200' levels, and most likely is on the 300' level also. Therefore, any chemical effect that either the diabase or porphyry rock has on precipitating ore minerals from the uprising solutions on the 100' level are duplicated on the levels below.

The vein structure is open and shows the action of mineralizing waters and vapors in the alteration of the porphyry wall rocks and replaced diabase.

That the vein is saturated with water shows it is not a tight fissure unfavorable to ore deposition, and the fact that the water drains off in a few days shows that we are not at water level yet The 200' level is practically dry now and the 300' level in 4 days time had dried up 50% as compared to the day the vein was cut.

All this goes to point that well directed prospecting will uncover ore bodies in this and other veins in the Jemison claims that will well repay the company.

Ore shoots are the exception and not the rule, and even when the most favorable combinations of influences exist, such as certain wall rocks, size of fissure, etc. sometimes no ore shoots are found.

It seems all the fovorable conditions are met in the Jemison: igneous intrussions, fissures, cutting both acidic and basic rocks, enough ore in the veins where opened to show that the fissure tapped the reservoirs that supplied the uprising solutions with their charge of ore minerals, and surrounded on all sides by mines of proved worth.

That ore shoots of value will not be found by very little more development is unbelievable.

That the richest part of this vein is to be looked for at depth greater than the 300' level is my opinion, based on the fact that veins of the same type in the neighboring producing mines are not big producers so close to the surface. This is brought out more fully in my first report on the Jemison.

Another ore showing that should be prospected is along the foot wall of the Broncho Dyke to the North of the Jemison tunnel. There are striking showings of mineralization along here for several hundred feet. Oxidized copper minerals, silicate and carbonates, coat brecciated diabase and much honey combed, iron stained vein quartz is found in place and as float.

A 10" sample of this outcropping quartz on the Mamouth Claim ran $0.40 gold, 6.86 oz. silver, 5.53% copper, and a 20" sample next to it ran $0.20 gold, 2.59 oz. silver, 1.58% copper. This portion of the dyke can be advantagiously prospected by extending the "water tunnel" N. 30 degrees E. 200 feet and attain a depth of about 92'.

The above samples of course were of leached outcropping quartz and the values are merely indicative of much higher values below.

On the hanging wall side of the Broncho Dyke there is a well defined vein outcropping about 4 feet wide showing abundent galena and oxidized minerals.

This will be prospected at depth, probably by a shaft on the vein.

Other claims to the East higher up the hill having good outcropping veins can be secured on very favorable terms as the Jemison holds the key for their development at depth.

They are inaccessible without the Jemison group as an outlet.

CONCLUSION:

Developments to date are satisfactory. The vein is continuous as to length, depth, and mineralization.

Veins having continuous and uniform ore are the exception. Lean or even barren portions are to be expected.

Conditions are good for this vein and the other veins to develop ore shoots of considerable size and richness.

RECOMMENDATIONS:

That the oreshowing on the Foot Wall of the dyke be prospected, also the lead vein referred to.

That the 300' level be continued N.W. to the dyke and the contact there be prospected. Also as the 300' level is carried S. E. that occasional crosscuts be driven to prospect for parallel veins in the porphyritic rock that promises to be the country rock in this direction.

The porphyritic rock develops a sheeted condition and is very likely to be the receptical for ore deposition, arising from the diabase intrusion to the N.E.

Also, the shaft sinking should be continued.

Yours truly,

(signed) W. W. Lytzen, E. M.

Dated September 21, 1917.

## Summary

The Jemison is an exceptionally good prospect. There is less gamble than usual as to opening ore in guantity and in the metallic content of the ore. The physical condition of the metals is not as refractory as others in the district that are being successfully treated. Milling conditions are improving almost daily.

The vein is strong and like all the others of the Cerbat Mountains will undoubtedly continue to great depth& The bottom of the shoots have not yet been reached in any mine with which the writer is familiar. Two troperties are developed over 1200 feet in depth. Two shoots on the Jemison are assured and adjoining ground will probably give others. It is true in the district, so far, that surface shoots have all continued in ore with deeper development and development has in several cases opened shoots of ore that were not indicated in the veins at the surface.

There is no tonnage blocked out, but 170 feet of drifting in the lower Jemison tunnel is in ore that will yield good profit. Experiments so far made indicate that by means of gravity and floatation concentration, combined with partial roasting and m magnetic separation of the iron from the zinc products will be made such that the operator of the Jemison will get paid for 80% or more of the metallic content of the ore.

This property is in Mohave County, Arizona. It is on the West slope of the Cerbat Mountains, about half way between Kingman and Chloride. It is reached by road in seventeen miles from Kingman, which is on the main line of the Santa Fe Railroad. The mine is four miles from Mineral, a station on the branch railroad running from Kingman to Chloride.

The wagon road from Kingman is passable to automobiles but the last two miles to this property are very bad and would be unsuitable for trucks at present, being up a rocky gulch. The rise is 150 ft. to 200 ft. to the mile. This poor portion of the road is the branch from the main truck road to Golconda and serves at this time no other property than the Jemison. A suitable road for Ore hauling from the Junction of the Golconda road to the mine will cost about $3500.00 The present road, though subject to repeated washing out, is sufficiently good to handle all freight etc., by teams and wagon during preliminary and development operations.

Telephone and electric power lines pass within a mile of the Property. The nearest post-office is "Golconda", at the Golconda Mine about a mile and a half by foot trail to the south.

Kingman is the main supply point. It is a town of 5,000 people and the various stores and su supply houses carry everything in stock that is necessary of all except the largest operations.

There are several surveyors and assayers available doing custom work. Haff and Colwell, whose permanent address is Oatman,Arizona, are very reliable for anything in the way of surveying and R.C.Jacobson,Kingman,is a careful and reliable assayer.

Throughout the section fuel oil or electricity from the Desert Power and Water Company is used for power. On small installations the former is usually the cheapest as the rate for current is 2-1/2 cents per Kilo-watt for small quantities,decreasing to 1¢7/8¢ per kilo-watt on a consumption of 400,000 kilo-watts per month. This is roughly equivalent to $12.00 to $15.00 per *.O. per month. Timber is a serious item as "O.P." (Douglass Fir) costs $28.00 to $35.00 per M. in Kingman in carload lots. Fuel oil costs from 4¢1/2¢ up,F.O.B. Kingman. Distillate for Hoists etc., ranges around 11¢ per gallon. For this particular case electricity would be the best for any preliminary operations due to the road conditions unless the mine is sufficiently developed when the time comes to put in Machinery to warrent a permanent road. Depending on hauled fuel with the present road would bee too uncertain.

There is available water on the ground for all domestic purposes for some time to come . All the mines in the district make water with depth, ranging up to 150 gallons per minute. The mines are the source of all water for milling purposes.

At present the principal producing properties of the district are the Golconda (Union Basin Mining Company) and the Yennessee (U.S.Smelting,Refining and Mining Company). The Golconda is about a mile, in an air line,south of the Jemison. It is developed to some 1200 feet in depth and is at present producing about 1800 tons monthly of zinc ore and concentrate running 40% zinc and carrying a little gold and silver.

The Banner mine of the Arizona Butte Mining Company is producing a little lead concentrate. Various other properties are making intermittent shipments.

The production of the district was originally almost entirely silver. The surface ores in numerous places were rich in native silver,horn silver and ruby silver. As depth was gained the precious metals decreased but large bodies of base metals were opened, principally zinc and lead with occasional copper bodies. It is these base metals that make the mines of to-day.

The Keystone mine has a mill under construction and there are two custom mills being talked about. One of the custom mills is being considered by the Zinc Concentrating Company,who will begin erection as soon as they are reasonably assured of tonnage. Their mill as outlined, will include roasting and magnetic separation as well as the usual wer methods. They are in the feild for zinc product high in iron.

The Jemison group consists of four locations relatively situated as shown on the accompanying map. There are some seventy-five acres or so covered. The map shows the ground as it is monumented. The claims are all irregular and in the case of the "White and Blue" claim the location may be illegal. I would earnestly recommend that as soon as the mine work will warrant, amended locations be made and the claims brought within the legal limits as to size and that the exterior lines be made parallel and corner posts put up.

There are no permanent improvements on the ground. There are tents and camp equipment sufficient for five or six men. All work now is by hand, no machinery.

There have been numerous articles published about the mines in the Cerbar Mountains, but the summary and the most reliable information given the general public is the U.S.Geological Survey Bulletin No.397 where Mr.!.?.$chrader gives the results of his study of the section made during the winter of 1906 and 1907. Mr.Schrader published a later article at page 1935 in the November 1916 Bulletin of the American Institute of Mining Engineers.

At the Jemison the country rock is the usual Pre-Cambrian Complex" of the Cergat Mountains. It exists here as a medium grained granite, with a little of the jointing and gneise forming action. There have been two sets of intrusions; Mr.Schrader speaks of them as "Tertiary" and "Pre-Teritary".

The "Pre-Teritary" is represented on this ground by the "Broncho Dyke", which runs the lengths of the Mammoth and Mendocino claims. The dyke was the reason for locating and is the "vein" of these claims. It strikes nearly north and south and continues to the south well into the Golconda Extension holdings and to the north about 1000' beyond the end line of the Mammoth claim. It has a total length of some 4500 feet.

The Tertiary intrusives are not positively identified on this ground, though a latite(?) that appears near the common end line of the Mendocino and Mammoth claims and which strikes a little west of south from the Broncho Dyke probably belongs to this group. Just to the west of these claims is the Pasadena Dyke. It is one of the Tertiary rhy rhyolites which strikes N.10 to 30 W. and a similar one is seen at the top of the ridge of the range near the south east end of the Night Hawk.

While no appreciable tonnage has been found on any of the dykes, values in gold and silver can be obtained almost anywhere along their strikes and in places several tons have been taken out that are very rich. The indications however, are that these pockets are purely surface enrichment.

The mines of the district are all on well defined veins that make out at sharp angles to the dykes. Mineralization has followed both sets of intrusions. Though it is by no means a proven fact, and further development and observation may prove otherwise, the present indications are that the veins making out from the Pre-Tertiary dykes are richer in copper, iron and gold, while those out from the Tertiary are richer in silver and lead. This does not apply, however, To a large area near Mineral Park where there is a disseminated pyrite carrying copper in a rhyolite porphyry that has produced a number of secondarily enriched copper deposits. The Galena usually gives way to iron and the iron to zinc. Due to heavy and rapid errosion ~~and~~ the oxidized zone is shallow and primary sulphides are often found close to the s surface. In many places the surface zone is that of secondary enrichment. Much ruby silver was found in the early days in the oxidized ore. Both in the oxidized and in the sulphide zones the various base metals showings are refactory mixtures of pyrite, chalcopyrite, blend and galena. In the past some of these ores have proven too refractory to handle. At present, however, unless the conditions are exceptional, almost any suplhides can be separated and marketed. with a saving of better than 80%. By this is meant that various combinations of flotation with a partial roast and magnetic separation have given both in practice and in experimental work clean marketable products.

It is well to remember that the so-called blend of the Cerbats is really not a straight zinc, sulphide, but is in fact a marmatite; that is an iron-zinc s sulphide, the iron being chemically combined. The result is that a forty-five to forty-six per cent Zn concentrate is as rich as can ordinarily be made. The pure mineral runs but 51% Zn.

The promising showing of this ground is on the Jemison vein. This strikes S.47 degrees E. and m makes out from the Broncho Dyke at about the middle of the Mendocino claim. It is traceable definitely nearly to the S.E. end of the Jemison claim. At a point about 200 feet from the Broncho Dyke a branch vein takes off which strikes about S.68 Degrees E.

A tunnel has been driven to the intersection of the dyke and vein and from the intersection is continued as a drift on the vein. On December 25th, 1916, it opened the vein for 170 feet. Values and sampling are indicated on the accompanying assay map. The face is still in very good looking ore. There are three upper tunnels that develop the vein to a certain extent. The two upper tunnels are in oxidized material entirely though occassionally a speck or two of sulphide remains. An old stope near the face of the upper tunnels is reported to have produced several hundred tons of ore going $200.00, the values being mainly in gold. This stope, though caved, shows a shoot apparently about 40 ft. long. The tunnel is on the vein for nearly 300 feet before getting into the stope.

The lowest of these three upper tunnels is really a crosscut and evidently only reaches the branch vein mentioned above. The vein width wherever mineralized is from two to five feet wide and so f far averages 3.25 feet. The ore will evidently occur in shoots. The one in the lower tunnel now being driven, so far is shown to be over 200 feet in length.

The shoot indicated in the upper tunnel by the old stope can be expected by comparison, as a little greater depth is attained, to be longer tha than the 40 feet now shown. It would be reasonable to expect, out of a length of vein of 1500 feet, that at least one third of it would be mineralized, and entirely possible that there would be even more. Barren zones will unboubtedly be encountered in drifting along the vein, but the croppings and the experience thruout the district would indicate that values would be found along one third of the veins length. The Jemison vein is lost on the surface near the upper (S.E.) end of the claim, but the indications are that the vein showing on the Little Johnnie is the same.

At present time there is nothing in any of the upper tunnels to be considered,except that a shoot of ore is quite positively indicated by the old caved stope. The middle or cross cut tunnel, so far only cuts the branch vein.

The showing that gives the property its principal value is in the Main or lower tunnel. As this leaves the dyke and penetrates the hill it gets more and more into the unaltered ,primary, sulphides. The present face (12-24-16) shows very little oxidation. The ore is a mixture of sulphies of iron,Copper,Zinc, and Lead "i.e." Pyride,Chalcopyrite, Blend and Galena. There are bunches of Arsenopyrite intermittently along the foot wall. The relative proportions of the minerals are best seen in the analyses on the assay map and particularly in the analyses of the dump samples. In places there are signs of secondary enrichment,but the zone is apparently thin. Some of the higher assays of copper are undoubtedly due to secondary glance. It is to be expected that the copper will decrease as one gets farther from the dyke and also that it will decrease with depth. This has been the case at the Alpha and other properties in the vicinity, but it is true that none of them had as much chalcopyrite showing in their upper works as the Jemison.

There is nothing in the was of "Blocked out Ore" at present. One might stope a little but the backs are shallow and two near the oxidized and leached zone. In driving the present main tunnel-the material could be sorted carefully and approximately 15% of the ground broken would be available for shipping. The Jemison vein now averages 3.25 feet wide, which means 65 tons each foot of depth on a shoot 200 feet long.

Driving three feet a day, would mean some 90 cu. ft. or about 8 tons, 15% of which or 1.2 tons is available for direct shipment, after hand sorting, as long as present conditions remain unchanged. This 1.2 tons would be about, as indicated by the sampling; AU. 0.15 oz, Ag 30.0 oz, Cu. 7.0%, Pb 1.5%, Zn. 6.5% FE 12.0%. This would yeild;

| | |
|---|---|
| AU. | $ 3.00 |
| Ag. 95% at 60¢ | 15.10 |
| Cu. 7% gets paid for 120 lbs at say 25¢ quoted less 2.5¢ for marketing charge | 27.00 |

This is about a $45.00 ore:

Hauling to the railroad now would be at least $3.00, which with $7.00 freight and $7.00 treatment or $45.00 less $17.00, would leave a balance of $28.00 as the value of the product on the dump. This indicates that for a while at least $30.00 to $35.00 could be realized a day. This would ma materially help,but would not pay all expenses, assuming hand mining and hand sorting on three shif shifts. It would take expecially good work to make three feet with hand steel. Bunches of arsenopyrite occur in a streak on the footwall and this product can be segregated in drifting and made to yeild some return as it carries hight gold values, averaging one and one half ounces. Its tonnage is however, decidedly limited. A selected piece of the assenopyrite gave 30 ounces gold per ton.

Depending on the policy of the operators, it might not be worth while at this time,to try to make any of the above segregations,but to put all the material on the dump to be handled later by mill or otherwise. It will be hard to save thh material in dumps as there is no place that will be free fro from possible loss by freshets. The metal prices are more apt to decrease than to hold their present values.

The ore markets at present are Humbolt, Sasco and Hayden for Copper products, while the nearest lead smelters are Selby and El Paso. Zinc products of this section usually go to Bartletsville,Okla. Some products can be marketed at the Needles Concentrator of the U&S&Smelting,refining and Mining Company. The latter plant takes some complex ores of the Cerbat Mountains when they are richer in lead , for a treatment charge of from $2.50 to $3.00 They buy the lead concentrate they make and hold the zinc concentrate or other product on "shippers order"

Mining costs, including developing and milling, can be reasonably estimated at $5.00 a ton on the Jemison. The Golconda is working at this figure and their conditions are exceptionally difficult. The Golconda mines their vein in places at a width of only 12 onches and yet keep their average figure down to the above $5.00. They allow $1.25 of that for development. $1.25 is a fair allowance for putting the ore or concentrate on the cars, assuming a fair truck road. The usual figure for this section for freight and treatment on material of average grade is $14.00 for lead, iron and copper products. When Spelter is quoted at seven cents, 40% zinc prod products are worth $20.00 to $21.00 a ton loaded on the cars at Mohave County common points.

The Jemison will mine cheaply by comparison, as the width is good and the walls stand well. The vein being practically vertical also helps.

Of the surrounding ground, there is nothing of interest at present to the immediate west and north. To the south is the Ora Plata Mine of the Golconda Extension Company. It has a shaft 360 feet deep. The property has a number of cross breaks or veins out from the Broncho Dyke. They produced much high grade ore in the early days, its past production having been supposed to be $500,000.00. Some copper showed near the surface, but apparently not as much as at the Jemison. From the 100 to the 285 levels, the ore became ver refractory, being a mixture of Pyrite, Galena and Blend, high in iron. It was high in total metal values, but hard to segregate. On the 360 foot lebel a marked decrease in the pyrite and increase in zinc occurred. The lead seemed to hold about the same. No ore was hipped or treated from the lower (360) foot level, but it was seen by the writer just before it was allowed to fill with water and the showing was very attractive. At that time, January 1916, the property was under option to O.A.Turner who owing to financial difficulties was unable to hold the property and it eventually reverted to the owners, Mr.O.D.M.Gaddis, et al, of Kingman. It has been recently (Dec.1916) re-optioned and work of unwatering is being started. The old shaft is small and in bad condition so it is proposed to drive a long tunnel from near the Golconda Road which will cut the old shaft between 300 and 325 feet. This tunnel cross cuts a number of veins showing on the surface. The mine makes about QTP gallons of water a minute. It is described on page 100 of U.S.Geological Survey Bulletin No.397.

The surrounding ground which is most interesting to the operators of the Jemison, is that which lies to the south east and east. I refer to the Clamp claims and the Night Hawk. Their relative position is whown on the accompanying maps. There is very little work that amounts to anything on the Clamp ground, but as has been said before, the Jemison vein is probably contined as the vein on the Little Johnnie Claim. The amended claims would have a common end line. There is every indication of a shoot near the middle of the Little Johnnie and beyond the Little Johnnie is the ground of the Nelson Bros. who have some high grade surface enrichment ore and every indication of two shoots, however, it is too far a sway to be of particular interest at this time.

The Night Hawk Mine consists of two claims; the Night Hawk and Rip Van Winkle. It is briefly described on Page 103 of U.S. Geol. Survey Bul. No. 397. Some very high grade gold and silver ore has been taken out in the past and there is every indication of strength in the bottom of the present lowest workings. It is now being worked by leasers, who shipped this fall (1916) a car of hand sorted material that netted them over $300.00 per ton. The Night Hawk has a long strong shoot and though it is narrow, being only about 18 inches to two feet wide, its higher values make it attractive. No systematic sampling has been done on the property as it is not so situated as to be readily handled as an individual property. There are two ways it could be worked; by long tunnel from the north west end of the Scotty claim, owned by Paul White, which would be a drift, ir by a cross cut from the Jemison, assuming that the Jemison tunnel is driven to or under Clamps Little Johnnie claim. This latter is the more attractive. In the natural course of events, the Jemison tunnel will reach the Clamp ground and from there the cross cut to the Night Hawk, will be over 1000 feet shorter than the drift from the Scotty. This would also cross cut the veins on Clamps Mint claim as well as several minor veins that show on the surface. It is true that only minor ore shoots are seen at the surface on this intervening ground, but it is much more promising than a drift with the country. The cross cut would also have a little greater depth. The whole question of the Night Hawk in connection with the Jemison, is one of the future, but it should be considered to a certain extent when figuring on possibilities. The control is in the hands of Mr. I. M. George of Kingman, who will be found a very reasonable man with whom to do business.

Experiments have been made demonstrating the success of floatation and of partial roast and magnetic separation,as a means of treating the ores of the Cerbat Mountains.

Jig and table concentrates are made which take care of the lead. The middle product is given a partial roast and then sent to a megnetic separator giving zinc and iron products. The copper will be with the iron and is shipped by itself. If the copper content is low, the iron is conbined with the lead concentrate and sent to the lead smelters. The slimes and tailings from the above treatment are put thru floatation machines.

The Fractions between the Jmeison, Little Johnnie and Valley View No.1 claims, whould be located at once. Clamp should locate the fraction between the Rip Van Winkle and the Mint.

An option should be obtained on the Clamp holdings.

Amended location notices and corner posts should be put up at once.

Additional and more substantial camp facilities should be provided and telephone communication established with Kingman, which latter can be done wit with three quarters of a mile of line to the Ora Plata.

Some ground on the slope a half mile to a mile west of the present camp should be located for a possible future Mill site.

The present lower tunnel should be pushed with all possible speed to prove the length of the present ore shoot and to open the ore at the other end of the claim. Whereas the present shoot near the Broncho Dyke should be developed to a greater depth, it is the feeling that the horinzontal extent and the existance and length of other shoots is the mostmost important thing for the immediate future..

The installation of machinery is dependent on the policy and finances of the operators with regard to the terms of their option.

N_O_T_E

It is found that the name "Clamp" in the text and on the Maps,should be"Klemp". The gentlemans name is _eo. Klemp.