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QUICKSILVER DEPOSITS

OF THE

PILOT MOUNTAINS, MINERAL COUNTY, NEVADA

BY

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QUICKSILVER DEPOSITS OF THE PILOT MOUNTAINS, MINERAL COUNTY, NEVADA

By WILLIAM F. FOSHAG

INTRODUCTION

In the course of general geologic mapping of the Hawthorne quadrangle, in western Nevada, the writer undertook a short study of the quicksilver deposits of the Pilot Mountains. The work was done under the supervision of Henry G. Ferguson, in charge of the field work in the Hawthorne quadrangle, and the writer was accompanied by L. B. Spencer, mining engineer, of Mina, Nev., whose intimate knowledge of the district greatly facilitated the study and to whom the writer is indebted for much valuable information. Data on the general geology of the district, collected by Messrs. Ferguson and Cathcart, were freely drawn upon.

The deposits of the Pilot Mountains were first described by Knopf [1] and later briefly by Ransome.[2]

GEOGRAPHY

The Pilot Mountains are situated in the west-central part of Nevada about 45 miles northwest of Tonopah. The area herein described, shown in Figure 7, lies in Mineral County, immediately east of Mina, the chief supply point for this region. The eastern part of the range is in the Tonopah quadrangle and the western part is in the Hawthorne quadrangle. On the south, with only a high valley intervening, the Pilot Mountains pass into the Monte Cristo Range; on the north they join the Gabbs Valley Range. They are bordered on the east by Graham Valley, and their western front rises abruptly out of Soda Spring Valley.

The district is best reached from Mina, a station on the Southern Pacific Railroad, whence roads pass around the northern part of the mountains to Simon and Cloverdale and south to Tonopah. A good

[1] Knopf, Adolph, Some cinnabar deposits in western Nevada: U. S. Geol. Survey Bull. 620, pp. 59–62, 1916.

[2] Ransome, F. L., Quicksilver: U. S. Geol. Survey Mineral Resources, 1927, pt. 1, pp. 417–418, 1921.

road which starts from the Cloverdale road follows Cinnabar Gulch and penetrates the range as far as Cinnabar Mountain, and another road follows Dunlop Gulch and reaches the foot of Pilot Peak. From Summit Spring, a well-known watering place on the Mina-Tonopah road, an old road leads north to the south flank of Cinnabar Mountain. The distance from Mina to the mines by way of Cinnabar Gulch is 12 miles and by way of the Tonopah road and Summit Spring 25 miles.

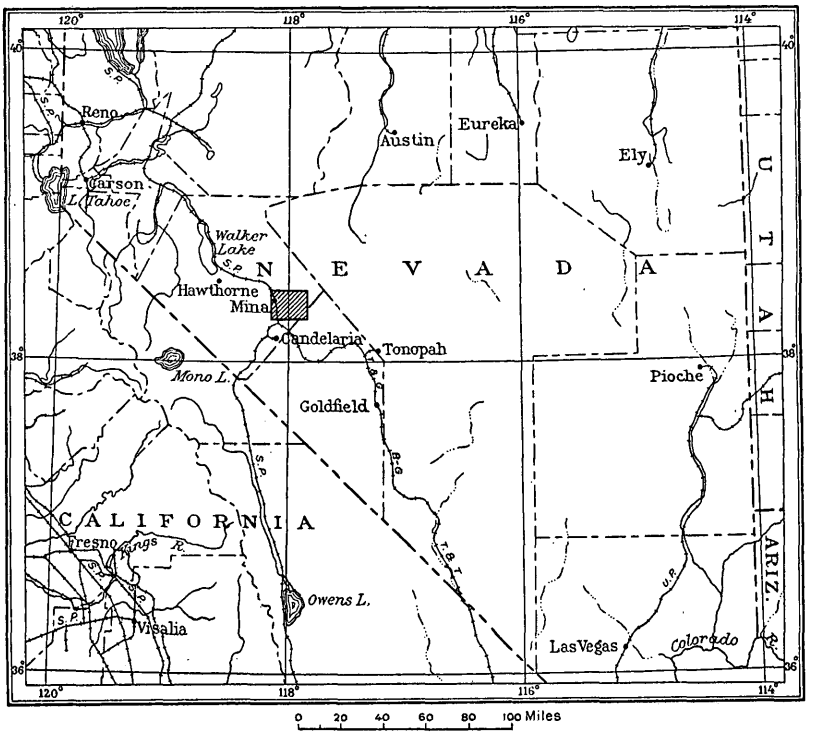


FIGURE 7.—Index map showing the location of the Pilot Mountains, Nev. (shaded area)

Pilot Peak, the highest peak of the range, rises to an altitude of 9,207 feet, and some of the ridges attain more than 8,500 feet. The range consists of two main ridges which trend northwestward and are joined by the long, high ridge of Cinnabar Mountain. From Cinnabar Mountain a long, narrow valley, locally known as Drew Gulch, extends southward to the Mina-Tonopah road, and Cinnabar and Dunlop Gulches lead northward to the valley followed by the Mina-Cloverdale road. The quicksilver mines are on the northwest and southeast slopes of Cinnabar Mountain.

Small springs of good water are found on the Pilot range in a number of places. The higher slopes carry a scattered growth of juniper suitable for fuel but not for mine timber.

GEOLOGY

The Pilot Mountains (pl. 9) consist largely of Triassic sedimentary and volcanic rocks, Jurassic or Cretaceous intrusive rocks, Tertiary and Pleistocene (?) volcanic flows, and Tertiary lake beds belonging to the Esmeralda formation. The older rocks in general form eastward-trending belts with northerly dips except in the southern part of the range, where the dips are southerly.

The Triassic rocks may be divided into three groups. The lowest group, which is exposed on the southern slopes of the range, consists largely of volcanic materials. The predominant rock is a compact cherty tuff made up of fine-grained ash and now largely silicified. It is thin bedded and contains thin seams of shale between the laminae in many places; here and there it shows rhythmic banding. Associated with the tuff are flows of andesite, now somewhat altered, beds of sandstone, and a few intrusions of porphyritic diabase. These rocks are well exposed along the Mina-Tonopah road, on the south slope of Cinnabar Mountain, and at other places in the southern part of the range.

Lying unconformably upon the lower group is the middle group, a sequence of conglomerate and sandstone which contain near the top lenticular beds of limestone. The conglomerate and sandstone have a characteristic red color and are made up largely of chert fragments. Near the middle of the group some beds carry pebbles of limestone as well as chert. These beds are well exposed in Dunlop Gulch, but the upper limestone-bearing member of the group is seen best at the head of Cinnabar Gulch.

The upper group of the Triassic rocks consists of a series of limestone and slate with some sandstone, conglomerate, and tuff. The limestone is gray and relatively thick bedded, and much of it is fossiliferous. These rocks form a broad belt across the north end of the range and are well exposed in Dunlop and Cinnabar Gulches and south of Battles Well, where they form prominent outcrops.

Along the western front of the range, especially in the vicinity of Fleming Canyon, granitic intrusions of Jurassic or Cretaceous age are found.

The Tertiary volcanic rocks are exposed on the extreme northern and southern flanks of the range and consist principally of rhyolite, andesite, and andesitic agglomerate. They are well exposed along the Mina-Tonopah and Mina-Simon roads. Small areas of these rocks are found in the range itself, especially at the head of Dunlop Gulch and in the low saddle between Dunlop and Cinnabar Gulches. At the latter place the rhyolite appears to be an intrusive mass. Some young basalts cap older rocks east and south of the range. The Tertiary lake beds are found on the north end of the range and

form the low slopes south and west of Battle's Well. They consist of fine clay with some sandstone and ash, and near their southern border they contain conglomerate derived from the Triassic rocks on the south.

ORE DEPOSITS

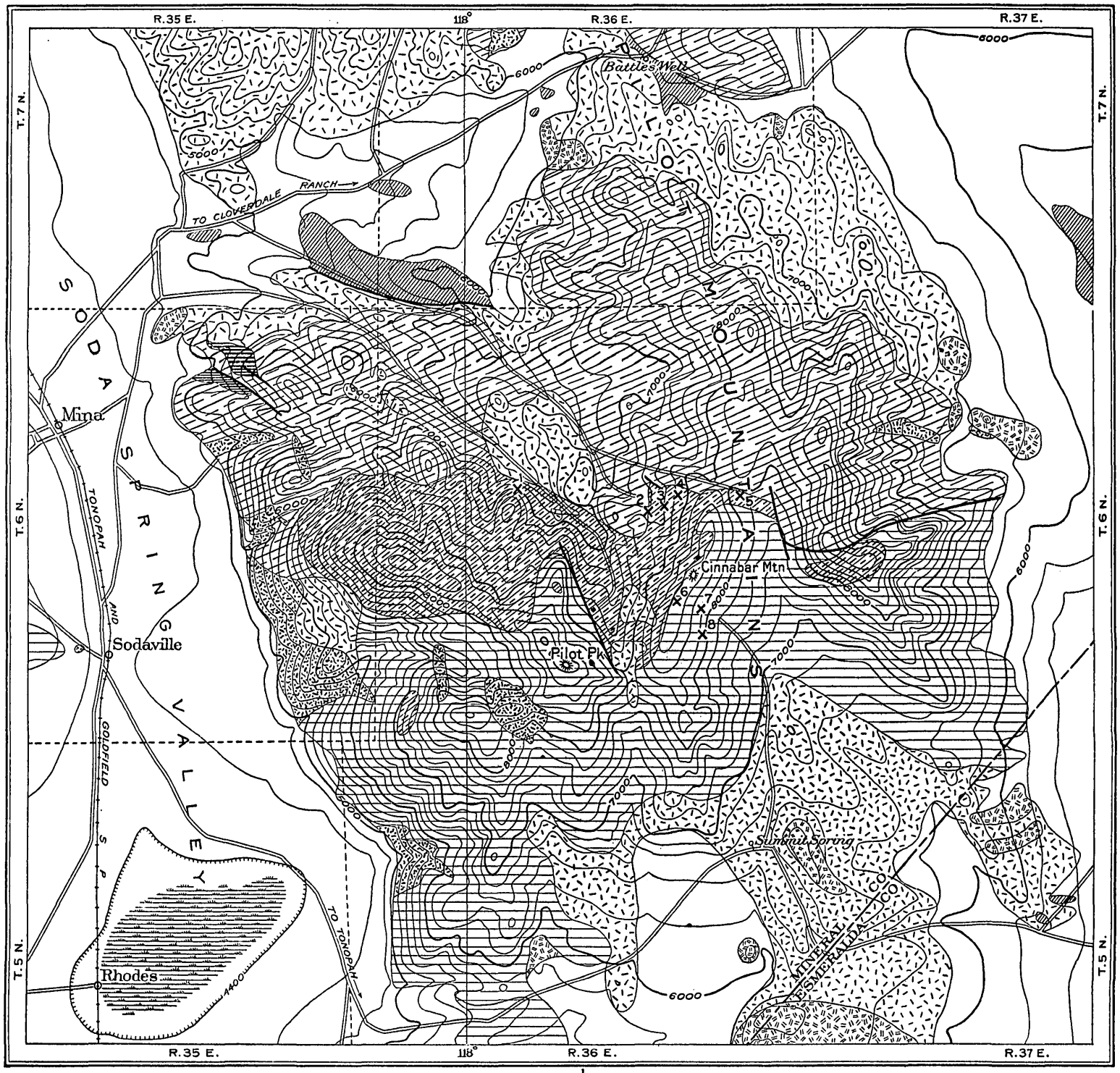
Distribution.—The quicksilver deposits all lie within an area of 7 square miles on and around Cinnabar Mountain, immediately northeast of Pilot Peak. (See pl. 9.) They fall into three general groups—those in Cinnabar Gulch, which occur in limestone, one in Dunlop Gulch, in conglomerate and sandstone, and those on the east flank of Cinnabar Mountain, in silicified tuff. The deposits thus far found impregnate and replace limestone, sandstone, and silicified tuff of Triassic age. Cinnabar in diabase of Triassic age and in Tertiary rhyolite has been reported, but none was found by the writer.

Metallic and gangue minerals.—Cinnabar, the sulphide of mercury, is the chief quicksilver mineral and occurs in two forms. The more abundant form is the usual clear material, of a bright vermilion color, much of it coarse grained, which is found in scattered grains or small masses in limestone, sandstone, or chert. The other variety, found only at the Drew mine, is a bright-scarlet earthy powder, which occurs intimately mixed with the lead antimonate, bindheimite, and the silicate of zinc, calamine. This form has the appearance of having been derived from some earlier mineral, probably mercurial tetrahedrite.

Other quicksilver minerals are rare. Calomel, the chloride of mercury, has been noted in some of the surface ore from the Lost Steers group as small oil-green crystals resembling horn silver. Native quicksilver has been reported but is rare.

Stibnite, the sulphide of antimony, is abundant in the Lost Steers group of claims and forms large masses of radiating or reticulated crystals in limestone. It is usually associated with some cinnabar and is accompanied by quartz. Oxidation products of the stibnite are the crystalline oxide of antimony, valentinite, the amorphous hydrous oxide, stibiconite, and sulphur. Valentinite occurs as pearl-gray crystals and massses pseudomorphous after the stibnite. Stibiconite is found in lemon-yellow to orange-yellow masses and blebs in stibnite or as a powdery filling of cavities. The sulphur occurs sparingly as small crystals associated with the valentinite.

Zinc is present in some abundance at the Drew mine, both as the sulphide, sphalerite, and more frequently as the hydrous silicate, calamine. The sphalerite forms fine granular masses of a dark-



EXPLANATION

- Pleistocene and Recent — Gravel and desert wash — QUATERNARY
- Pleistocene(?) — Basalt — QUATERNARY(?)
- Upper Miocene(?) — Rhyolite and andesite — TERTIARY
- Upper Miocene — Esmeralda formation — TERTIARY
- Granodiorite and quartz diorite — JURASSIC OR CRETACEOUS
- Red sandstone — TRIASSIC
- Slate and limestone — TRIASSIC
- Conglomerate and sandstone; limestone beds near top — TRIASSIC
- Chert, tuff, and greenstone — TRIASSIC
- Fault

MINES AND PROSPECTS

1 Easter
2 Wurtzler
3 Mina (Booth-Wardell)
4 Lost Steers
5 Red Devil (Drew)
6 Ramrod
7 RedWing
8 Bright Beauty

Topography from U.S.G.S. maps of Hawthorne and Tonopah quadrangles

Scale 1/125,000

1 0 1 2 3 4 5 Miles

Contour interval 200 feet

Geology by H.G.Ferguson and S.H.Cathcart

GEOLOGIC MAP OF THE PILOT MOUNTAINS, NEV.

brown color. The calamine always accompanies the earthy cinnabar or forms small radiating bunches of glassy crystals in vugs in the ore.

A mineral of interest, which occurs in some abundance in the Drew mine, is bindheimite, the antimonate of lead. All the earthy cinnabar carries some of this mineral in finely divided form, and occasionally small masses of the pure mineral are found. It is yellowish green and has a waxy luster. Some of it is in long-bladed crystals, a form no doubt inherited from the original sulphide mineral, probably a sulphantimonide of lead, but the original mineral has not yet been found.

Copper minerals are met with here and there in the deposits and include brochantite, azurite, and chrysocolla.

Gangue minerals are quartz, barite, and calcite. In those deposits which carry abundant antimony some silicification of the country rock has taken place. Silica is present in the form of quartz, usually as compact masses or as reticulated aggregates of small crystals. Calcite forms a common gangue for the bright-red cinnabar grains and is abundant in small seams and veins cutting the dark-gray limestone. Barite is somewhat abundant at the Chong Wong claim, where it cuts chert, and has also been found sparingly with stibnite and its oxidation products on the Lost Steers prospect. Pyrite is present only in very small quantities. It has been found in the Red Wing group associated with the cinnabar in the cherts, and a few small grains were noted in specimens of the limestone ore.

General nature.—The largest known ore bodies are those in the limestone, but the other deposits have not been as extensively worked and may also contain much high-grade ore. Although only the higher-grade ores have been mined, cinnabar in small pockets or as separate grains is widely scattered throughout the belt of known deposits, especially in the chert.

The cinnabar-bearing rocks are cut by many faults differing in dip and strike, and there are a great number of minor displacements. So far no cinnabar has been found along the larger displacements, but it is associated with minor shear zones. The ore may be in the sheared material itself or may spread for some distance into the wall rock. In the limestone the shear zones are usually well defined, and the ore bodies are persistent and easily followed. In the chert, however, the shattering is spread out, so that the ore shoots ramify more widely.

No intrusive igneous rocks occur in the immediate vicinity of the ore deposits, although there are masses of andesitic and rhyolitic rocks about the head of Dunlop Gulch, and the rhyolite east of the Easter prospect is apparently an intrusive body.

In the Drew mine and parts of the Lost Steers group the limestone has been replaced by silica on a small but appreciable scale. The silica was accompanied by antimony and zinc and to some extent by lead, giving rise to the primary sulphides stibnite, sphalerite, and a sulphantimonide of lead. The ore at the Drew mine is said to carry also some gold and silver. In the deposits free from silica the only sulphide found is cinnabar. The ores in the cherts contain a small quantity of silica and a little pyrite. Other minerals of the deposits—calamine, bindheimite, valentinite, stibiconite, sulphur, calomel, and mercury—are secondary and have resulted from oxidation of the primary sulphides.

Whether or not any of the ore has undergone enrichment is not known. Secondary quicksilver minerals are rare. In the Booth-Wardell mine some of the cinnabar seems to be certainly later than the shearing, but whether or not any of this has been leached from above and deposited below can not well be determined. It seems improbable, however, that much of the richness of the ores is due to such a process.

Origin.—Mercury ore bodies are generally believed to be hydrothermal deposits formed at relatively shallow depths. This is probably true of those in the Pilot Mountains. Alkaline solutions introduced the ore into the rock either by interstitial impregnation or by metasomatic replacement of the wall rock. Everywhere except in the Drew mine the principal original quicksilver mineral is cinnabar, but in this mine the association of cinnabar with the secondary minerals bindheimite and calamine and the fact that it occurs as a powdery filling of cavities suggests that it is also secondary and may have been derived from some earlier mineral, possibly mercurial tetrahedrite.

Age.—It may be suggested that the quicksilver deposits of the Pilot Mountains are connected with the intrusion of the granitic masses exposed on the west front of the range and therefore are of late Jurassic or early Cretaceous age, but it is more probable that they had their source in the Tertiary volcanic activity of which the lavas exposed in the vicinity are a manifestation. There is no direct evidence to connect them with the granitic intrusions, but if the reported occurrence of cinnabar in the Tertiary rhyolite is true it would place them definitely as of Tertiary age and would bring them into harmony with the other quicksilver deposits of the region—those at Ione and Beatty, Nev., in Tertiary volcanic rocks. The ore deposits of Aurora and of Manhattan, Nev., which are also Tertiary, carry some cinnabar.

Prospecting.—The high specific gravity of cinnabar makes its detection by panning a simple process. Any gulches of the district that show cinnabar colors should be systematically panned, and the

highest level at which the color can be found should be noted. As fracture zones or "breaks" are favorable places for the deposition of cinnabar, any that are found near by should be carefully scanned for showings of cinnabar and calomel, of the oxidation products of stibnite (valentinite and stibiconite), and of the lead antimonate, (bindheimite). Calomel can readily be recognized by its similarity to horn silver. As the deposits are probably Tertiary, any rocks of the area are possible country rocks for quicksilver.

PRODUCTION

All the quicksilver produced in this district has come from high-grade cinnabar ore, and most of it from two properties—the Drew mine and the Booth-Wardell mine—but some also from the Lost Steers group. Production began in 1915 and reached its maximum between 1917 and 1919. The total value of the quicksilver extracted is reported to have been about $200,000. Some of the ore charged into the retorts has been almost pure cinnabar, and 10 per cent ore was not uncommon.

FUTURE OF THE DISTRICT

The cinnabar produced in the Pilot Mountains has all been obtained from high-grade ore. There are still some reserves of good cinnabar ore, and most of the low-grade material remains untouched. None of the mines are deeper than 200 feet, and there is no apparent reason why good ore may not extend to greater depths in some of the deposits. The great hope for the future of the district, however, lies in the possibilities of large bodies of low-grade ore suitable for furnace treatment. Cinnabar is widely spread in this area, and in some places the rock may be of sufficient richness to constitute good ore for this means of treatment. This is especially true of the chert belt, where "cinnabar blossoms" are abundant and where some of the material is so situated that it can be taken out by the simple operation of quarrying. Whether or not the general tenor of this type of ore is sufficiently high for such treatment awaits determination by extensive sampling.

MINES AND PROSPECTS

Drew mine.—The Drew mine (formerly known as the Red Devil) is situated at the head of Cinnabar Gulch at an altitude of 7,800 feet. A good wagon road connects it with Mina.

The ore bodies lie in light-colored gritty calcareous sandstone and are of irregular form. On the west these beds abut against maroon sandstone and conglomerate, which may overlie the calcareous sandstone or be in fault contact with it. The general dip of the beds in

the vicinity of the camp is north or northeast, but farther east the dip is eastward. The stopes are small, but the ore mined is said to have been rich. The ore is more complex here than in any other part of the district. The mercury mineral is a powdery cinnabar intimately mixed with calamine and bindheimite. Dark-colored fine-grained sphalerite is also somewhat abundant. Masses of bright-red pulverulent cinnabar were common and yielded rich ore. Some ore is said to have carried as much as 18 per cent of quicksilver, 28 per cent of lead, and 44 ounces of silver and more than 1 ounce of gold to the ton. The gangue is quartz, which under the microscope is seen to be made up of interlocked prisms with hexagonal cross section.

The mine is opened by an inclined shaft about 200 feet deep, but most of the workings are now inaccessible. The ore was first treated in a 12-tube furnace, but the loss of quicksilver was so great that this type was replaced by D retorts. Juniper, of which there is an abundant supply, was used as fuel.

Booth-Wardell mine.—The Booth-Wardell mine was formerly a part of the Lost Steers group but is now the property of the Mina Mercury Mining Co. and in the district is often called the Seitz mine. It is on the north slope of Cinnabar Mountain at an altitude of 7,400 feet and is 12 miles from Mina by a good road.

The country rock is limestone, with which are interbedded thin layers of conglomerate, sandstone, and shale. The limestone is dark gray and considerably veined with white calcite. The strike of the beds is N. 50° W., and the dip 45°–60° N. The strike of the lode is the same as that of the beds, but the dip is somewhat steeper. The beds in which the deposits lie are lenticular bodies of limestone and are in places as thick as 100 feet. On the east the beds are cut off by a fault that follows Cinnabar Gulch, and on the west they gradually thin out and disappear. The richest ore is confined to a brecciated zone from 4 to 6 feet wide, which has a definite hanging wall but a somewhat obscure footwall. Cinnabar is almost the only sulphide present, although some small patches of stibnite and a few grains of pyrite are found. The cinnabar forms seams and bunches in the soft gangue or is finely disseminated through it. Fragments of slickensided ore are found, but most of the sulphide appears to be later than the main period of shearing. Beyond the sheared zone the cinnabar occurs as small scattered grains or bunches in the seams of white calcite that cut the dark limestone.

The deposit has been opened by an inclined shaft 88 feet deep. Several small stopes and short drifts constitute the underground workings. At the 40-foot level a rich lens of ore has been stoped

out. At the lower level a drift has been run along the course of the vein for about 100 feet, and the face shows excellent ore. The ore from this property has been treated in D retorts on the Lost Steers ground.

Lost Steers group.—The Lost Steers group of claims embraces the original cinnabar discovery of the district and is owned by Thomas Pepper and Charles Keogh. The original ground covered 11 claims, but a part of this ground has been purchased by the Mina Mercury Mining Co.

The country rock, like that of the Booth-Wardell mine is a fine-grained, dark-colored limestone, cut by many veinlets of white calcite, and sporadically carries cinnabar. Locally, cinnabar is found along small sheared zones or as impregnations in the calcite. The chief workings are at the lower end of the group, near the Booth-Wardell line. The ore body here is a continuation of the rich ore body on the Booth-Wardell property, but it soon pinches out on the Lost Steers ground. Near the summit of the ridge at the south end of the property several shallow workings have been opened in which some cinnabar associated with much stibnite has been exposed.

The chief production has come from workings at the north end of the group. Some of the stibnite from the southern part has been taken out as antimony ore, but none has been shipped. The ore has been treated in a D-retort furnace. There is a good spring on the property.

Wurtzler prospect.—North of the Booth-Wardell mine and lying in the same belt of limestone is the Wurtzler prospect, comprising four claims. The geology is similar to that of the adjacent properties. It is owned by August Wurtzler, of Mina.

Easter group.—The Easter prospect is in Dunlop Gulch about 1 mile north of the Booth-Wardell mine. It comprises six claims and is owned by Cornelius & Mace, of Mina. The ore bodies occupy minor shear zones in a sandstone lens in chert-limestone conglomerate. The ore mineral is cinnabar without other ore or gangue minerals. The cinnabar is scattered through the sandstone, replacing the cement, or forms small seams and irregular bunches in the massive sandstone. The property is opened by a short adit that has exposed some good ore. The prospect was discovered on Easter day, 1924, and to September, 1924, had produced 12 flasks of quicksilver. There is a good spring on the property and an abundance of piñon trees for fuel. The property is equipped with a D-retort furnace.

Red Wing group.—The Red Wing group comprises 16 claims and is owned by E. V. Messenger, of Mina. No regular production has been attempted, but in the course of development work approximately 12 flasks of quicksilver has been produced. The camp is on

the south flank of Cinnabar Mountain at an altitude of 7,800 feet and is about 2 miles distant from the Mina-Tonopah road. The distance by wagon road to Redlich, a station on the Tonopah & Goldfield Railroad, is 12 miles and to Mina 25 miles.

The ore deposits differ from those of the other properties on the north side of Cinnabar Mountain in that the country rock is a

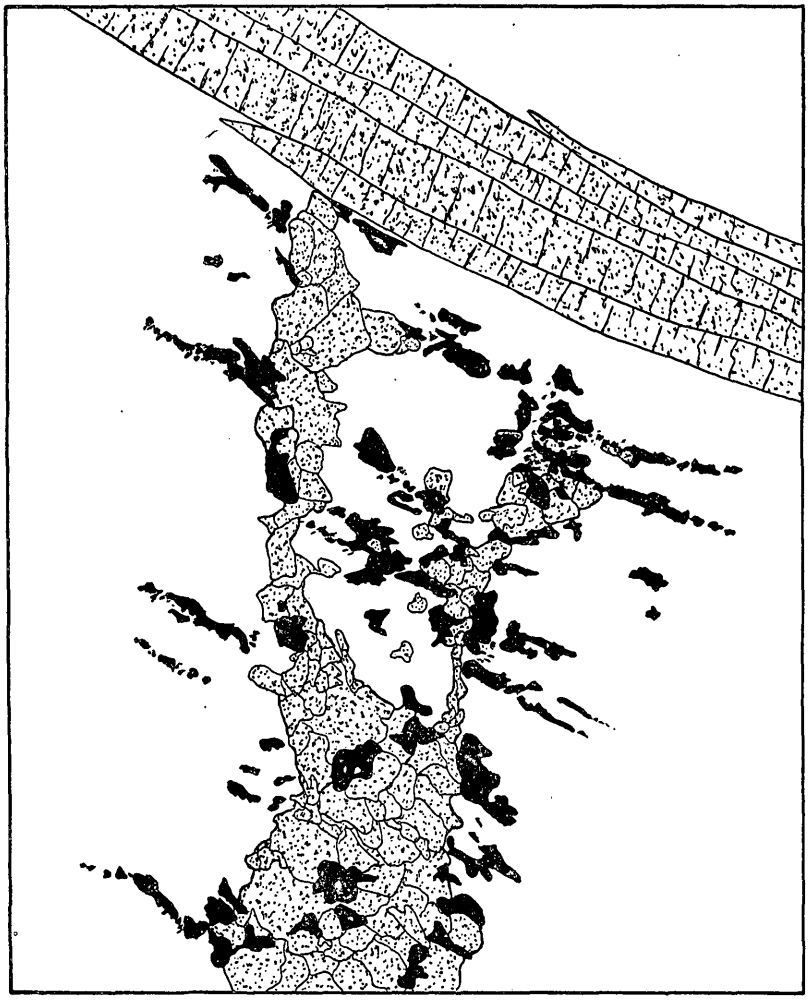


FIGURE 8.—Cinnabar and quartz replacing tuff, Red Wing group, Pilot Mountains, Nev. Black, cinnabar; stippled, quartz; white, tuff. Camera lucida sketch, enlarged about 26 diameters

cherty tuff or chert breccia and the ore has replaced the rock along small cracks, as shown in Figure 8. The rich bodies are small and irregular but at places are sufficiently numerous to constitute good ore. Throughout this group and the adjacent properties cinnabar "blossoms" are not uncommon and good pannings or float can be

had in a number of places. It is possible that sufficient cinnabar is scattered through the cherts to make good bodies of furnace ore.

The rock series that carries the cinnabar consists of light-colored chert, chert conglomerate with red cement, dark-red sandstone, a light-colored andesitic flow, and a dark grayish-green diabase porphyry. The chert is thin bedded and shows rhythmic banding and thin seams of shale. The sandstone and conglomerate carry abundant specular hematite in places. The strike of the beds is easterly in general and the dip is about 50° N. The diabase contains small lenses of quartz, which are said to carry some cinnabar.

The property has not been extensively explored, but a number of short adits and open cuts have been run where the surface showings have been good. The chief workings are in a zone of brecciated chert in which the cinnabar is present in some abundance as small seams and irregular bunches. The outcrop at this place forms a steep face of rock, and if the entire mass is found to be sufficiently rich for furnace ore a considerable tonnage can be quarried.

Ramrod group.—The Ramrod group comprises five claims lying immediately west of the Red Wing group and in the same series of chert and associated rocks. It is owned by Messenger & Betty, of Mina. The property has been opened by a few shallow open cuts and shows some good ore.

Bright Beauty prospect.—The Bright Beauty prospect, consisting of nine claims, adjoins the Red Wing group on the south. It is the property of Fred Fletcher, of Dyer. The rock is chert in contact with porphyry. Some good ore has been exposed, but no quicksilver has been produced.

Chong Wong prospect.—The Chong Wong prospect lies about a mile and a half northeast of the Drew mine and comprises three claims. The owner is Chong Wong, of San Francisco, Calif. The ore is cinnabar associated with barite in a chert country rock.

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