GEOLOGY OF THE YELLOW PINE CINNABAR-MINING DISTRICT, IDAHO.

By ESPER S. LARSEN and D. C. LIVINGSTON.

INTRODUCTION.

The Yellow Pine district was visited by Mr. Livingston, of the University of Idaho, early in August, 1918, and by Mr. Larsen, of the United States Geological Survey, a few weeks later. Mr. Livingston spent five days in the district and Mr. Larsen three.

Acknowledgments are due from both the authors to Mr. Walter Hovey Hill for claim maps of the district and also for an excellent detailed map of the workings and geology of the Fern mine. Acknowledgments are also due to all the operators of the district, especially to Mr. E. H. Van Meter, of the Fern mine, for personal courtesies and valuable assistance.

Three reports on the quicksilver deposits of the Yellow Pine mining district have been published. The district was first described by Robert N. Bell,[1] State mine inspector of Idaho, who also published a later report.[2] A somewhat more detailed report has been made by Mr. Livingston.[3]

LOCATION AND TOPOGRAPHY.

The Yellow Pine cinnabar district is in that part of Valley County, Idaho, which was formerly included in Idaho County. It is about 50 miles northeast of Cascade and about 7 miles from the site, now covered by water, of the town of Roosevelt, the short-lived center of the Thunder Mountain gold district. The cinnabar prospects are in the upper part of the drainage basin of Meadow Creek, a tributary of the East Fork of the South Fork of Salmon River. From Cascade they are reached by a poor mountain road about 70 miles long. An automobile can be taken as far as Knox, 26 miles, but the rest of the road is impassable for an automobile on account of high centers, rocks, steep grades, and general poor surface; it is even difficult for a

[1] Bell, R. N., Quicksilver and antimony discoveries in central Idaho: Idaho Mining Dept. Bull. 1, 1918.
[2] Bell, R. N., Twentieth annual report of the mining industry of Idaho for the year 1918, pp. 89–100, 1919.
[3] Livingston, D. C., Tungsten, cinnabar, molybdenum, and tin deposits of Idaho: Idaho Univ. School of Mines Bull. 2, vol. 14, pp. 55–65, 1919.

team and wagon. The cost of freighting from Cascade to the mines is about $100 a ton. The district is very rugged; the highest point is considerably over 8,000 feet above sea level, and the maximum relief is about 4,000 feet. The mountains are well watered and are covered with a good growth of spruce and black pine.

HISTORY.

The original discovery of cinnabar in this district was made by Pringle Smith during the Thunder Mountain boom in 1902, in a fork

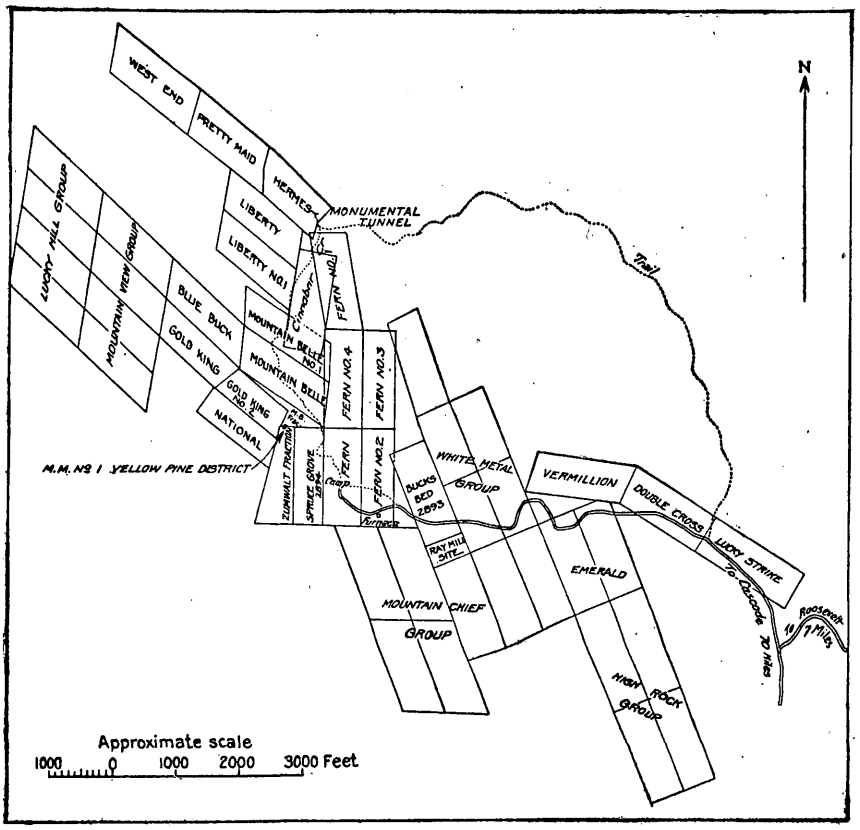

FIGURE 6.—Claim map of cinnabar camp in Yellow Pine mining district, Valley County, Idaho. By Walter Hovey Hill.

of Sugar Creek, afterward named Cinnabar Creek. Mr. Smith located the Hermes group at that time, and for many years he was the only prospector in the district. Prospecting for cinnabar was greatly stimulated by the high prices for the metal that prevailed during the world war, and in 1917 E. H. Van Meter located the Fern group of claims, adjoining the Hermes group on the south. Mr. Van Meter procured Boise capital and organized the Fern Quicksilver

Mining Co. In 1917 this company erected a bench of Johnson-McKay retorts capable of treating 2 tons of ore a day. Since then the whole surface near the cinnabar area has been staked with claims, and several companies and individuals have carried on active development work. (See fig. 6.)

PHYSIOGRAPHY.

The cinnabar deposits are practically in the center of the high mountain uplift of central Idaho. This mountain region, according to Umpleby,[4] is a highly elevated and deeply dissected plateau that was eroded practically to base-level during the Eocene epoch and was subsequently elevated and subjected to profound erosion by both streams and local glaciers.

The divides between the main streams have rather regular, nearly flat tops bordered by steep slopes which continue to the streams, several thousand feet below. The sky line, as seen from the top of any of the divides, is remarkably uniform, and all the divides have about the same elevation. Such a divide, with an elevation of about 8,500 feet, lies between Middle and South forks of Salmon River and is followed by the road from Reardon Creek Summit nearly to the quicksilver mines. Many peaks, such as Rainbow Peak, Mount Logan, and Thunder Mountain, rise several hundred or even a thousand feet above the general level of the divides. These are chiefly monadnocks, hills of resistant rock that stood up above the floor of the old peneplain.

The streams flow in canyons from 2,000 to 4,000 feet deep which steepen rapidly toward their heads; hence travel across the drainage lines is very difficult.

Local glaciation has modified the topography near the heads of the streams; many cirques are present, especially on the north and east sides of the ridges, and the upper stream valleys are generally U-shaped, with a broad apron of ground moraine in the valley bottom. Small grassy flats, the remnants of morainal lakes, exist in many of the cirques.

On the whole, the country in the immediate vicinity of the cinnabar prospects is mountainous but not particularly rugged, except where the hard quartzite rocks have been eroded to steep bluffs in the cirque walls by glaciers. Where the cinnabar occurs the relief is from 1,500 to 2,000 feet, the altitude ranging from a little less than 7,000 feet at Pringle Smith's cabin on Cinnabar Creek to 8,500 or 8,600 feet on the ridges separating Fern, Cinnabar, and Sugar creeks. The heads of these three creeks are occupied by cirques, in one of which stand the buildings at the Fern mine.

[4] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, pp. 22–30, 1913.

The relief of the country favors the development of most of the cinnabar prospects by means of tunnels for several hundred feet below the outcrops.

GEOLOGY.

GENERAL GEOLOGY OF THE AREA.

The cinnabar deposits lie in a body of sedimentary rocks, mostly limestones and quartzites, with considerable schist, that is reported by Bell [5] to be about 2 miles wide and 3 or 4 miles long. These rocks strike about northwest and are nearly vertical. They are intruded by granitic rock and represent an inclusion in the granitic rock or a roof pendant. West of the deposits, as far as Cascade, the bedrock is made up of granitic rock with a very few small inclusions of sedimentary rock. Between Cascade and the cinnabar deposits the granitic rock seen from the road for many miles east of Cascade appears to be rather uniformly a light-colored porphyritic biotite granodiorite, but beyond this granodiorite the rock is less uniform and much of it is fine-textured, sugary-grained granitic rock. For some miles west of the cinnabar prospects the rock is a coarse-grained pinkish granodiorite. These granitic rocks are no doubt a part of the great Cretaceous batholith of central Idaho.

South and east of the cinnabar district the granitic rocks and the eroded edges of the sediments are overlain by a considerable thickness of Tertiary volcanic rocks, mostly in flows. These rocks are probably quartz latites and andesites, and they are said to extend to the Thunder Mountain district. Some dikes of rhyolite porphyry and andesite intrude the sedimentary rocks and the granites, and they may be closely related to the volcanic rocks.

GEOLOGY OF THE CINNABAR DEPOSITS.

The cinnabar deposits are in the sedimentary rocks, for the most part in the limestones near their contacts with the schists and quartzites. The beds are nearly vertical or dip very steeply northeast. For the most part, they strike northwest; in lower Fern Creek they strike about N. 60° W., but near the head of the creek they turn sharply and, for some distance, strike nearly north. Farther northwest they appear again to strike northwest. A generalized section measured from the contact with the granodiorite on the ridge to the west of the head of Fern Creek, along this ridge, around the head of Fern Creek, and along the ridge to the west of Cinnabar Creek, is given on page 77. The thicknesses are only approximate. The order represents simply the succession in space, and the beds given first may be either the top or the bottom of the section.

[5] Bell, R. N., Twentieth annual report of the mining industry of Idaho, for 1918, p. 92, 1919.

Section across the sedimentary rocks from southwest to northeast along the ridges west of Fern and Cinnabar creeks.

Coarse, porphyritic granodiorite, intrusive into the sediments.	Feet.
Pebbly quartzite	300
Micaceous schist	330
Hard quartzite, very resistant	300
Pebbly quartzite	150
Marble, thin bedded and more or less altered to lime-silicate minerals in the northern part	600
Mica and andalusite schists	220
Quartzite	220
Schist	80
Quartzite	80
Micaceous schist	40
White sugary quartzite, with some pebbly beds near top	460
Dark quartzose schists, giving poor outcrops	40
Marble, with some thin layers of dark quartzite and schists	150
Nearly white sugary quartzite	200
Gray marble, well banded and less metamorphosed than marbles to the south. Only a part seen	1,000+
	4,170

In Fern Creek the quartzite and schist member, which is in contact with the granodiorite where the section was made, is succeeded to the north by another layer of marble.

In general the sediments have been considerably metamorphosed, probably during the intrusion of the granodiorite. The original limestones are now marbles, and they carry more or less silicate minerals, partly disseminated in the marble and partly aggregated in lenses or bunches of varying size. Locally, considerable bodies of the marble are replaced by lime-silicate rock. These bodies do not represent the replacement of a particular bed, as in places their long direction is across the bedding. In passing from the less silicified marble to the lime-silicate hornfels bodies, lenses, and layers of hornfels parallel to the bedding and an inch or so thick first appear in the marble, and the resulting rock has a prominent ribbed appearance on the outcrop due to alternating layers of marble and resistant hornfels. The hornfels bands may increase in size and abundance until they completely replace the marble. This hornfels is made up of quartz, orthoclase, diopside, tremolite, carbonates, and more or less phlogopite, epidote, titanite, magnetite, apatite, and a scapolite near wernerite ($Ma_{30}Me_{70}$). The marble is in part a calcite marble and in part a dolomite marble. It carries scattered crystals of phlogopite, tremolite, and diopside.

The original sandstones and quartzose conglomerates have been altered to hard quartzites, and the less pure sandstones to quartz schists. A specimen of the schist collected as typical of the thick schist layer on the ridge southwest of the Smith camp proved to be

made up mostly of andalusite, with some quartz, phlogopite, sericite, magnetite, and rutile.

No fossils were found in the sediments, and the lithology is not sufficiently characteristic to correlate them with near-by deposits of known age. Their general character and their relation to the granitic intrusive rock indicate that they are probably Paleozoic.

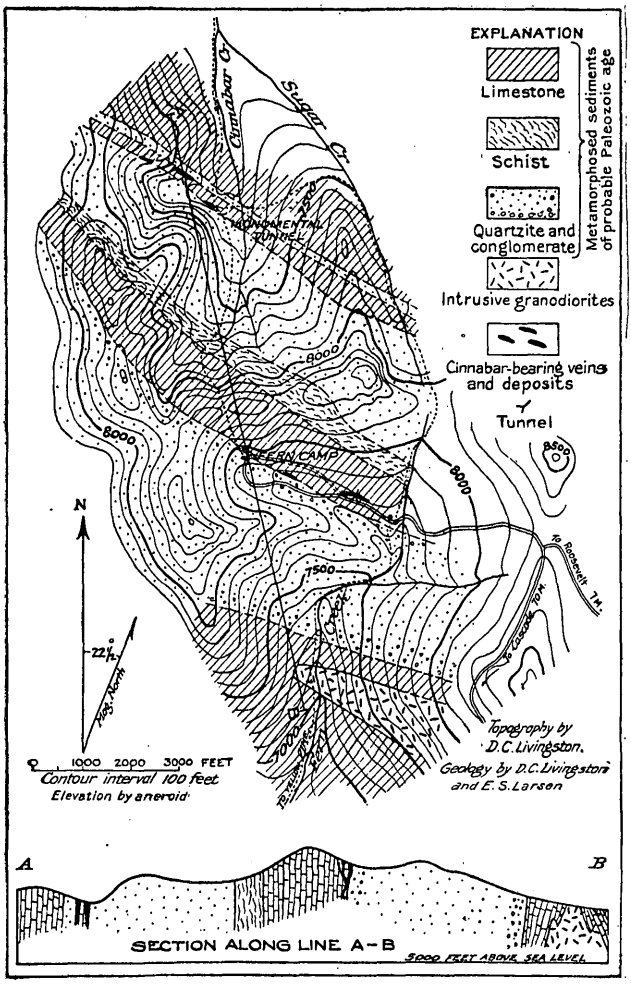

FIGURE 7.—Reconnaissance geologic sketch map of the Yellow Pine cinnabar district, Valley County, Idaho.

A number of dikes or less regular bodies of a rhyolite porphyry, some of them over 100 feet across, intrude the sediments. This rhyolite porphyry carries rather abundant crystals of orthoclase as much as 5 centimeters across and smaller crystals of quartz and biotite in a micrographic matrix of quartz and orthoclase, with some shreds of biotite and an altered prismatic mineral. A single small dike of hypersthene andesite was seen on the ridge at the head of

Fern Creek. These dikes are probably related to the Tertiary lavas that overlie the sediments less than a mile to the east of the cinnabar deposits. A generalized reconnaissance geologic map of the district is shown in figure 7.

ORE DEPOSITS.

GENERAL FEATURES.

The cinnabar prospects and mines lie in the upper drainage basins of Fern and Cinnabar creeks and are included in an area about a mile square. They are confined to the sedimentary rocks and are mostly in the marbles near the quartzites or schists and to a small extent in the quartzites adjoining the marbles. The Fern mine, on the upper part of Fern Creek; the Bucks Bed claims, to the east; and the White Metal group, still farther east, are near the southwest contact of one of the larger limestone layers with quartzites and conglomerates. The claims of H. T. Abstein lie still farther east and are probably near the northeast contact of the same limestone. The Hermes group of claims, about a mile north of the main workings of the Fern mine, are in a limestone member only about 150 feet thick that is separated from the limestone of the other prospects by over 1,000 feet of quartzites and schists. The lower workings are near and along the southwest contact of this marble; the workings farther up the small gulch to the northwest are near the northeast contact of the marble.

The cinnabar deposits appear to have been formed by replacement of the marble and to be mostly near the contacts of the marble with the quartzites or schists. No evidence was seen of continuous veins, but the deposits appear rather to be in the irregular or lenticular bodies that are common in replacement deposits in limestone. In some places the silica forms a network of anastomosing veinlets in the marble; in others it completely replaces the marble. Cinnabar is the only sulphide in most of the ore, although considerable pyrite, more or less altered, is present in some parts of the deposits, and stibnite is associated with cinnabar on the ridge just north of the Fern mine. The cinnabar is rather coarsely crystalline, and much of it is in the cherty silica, but some is in a friable sandy marble near the silica zones and some is disseminated in the hard white marble. A considerable part of the ore treated at the Fern mine came from material partly filling a cave in the marble and was made up of blocks of hard ore embedded in a cinnabar-rich sand.

The antimony deposits in the granodiorite just south of the cinnabar deposits carry a little cinnabar and are probably related in origin to those deposits; the antimony deposits about 15 miles to the west, near Yellow Pine post office, are also in granodiorite and are probably related deposits. The evidence as to the origin of the deposits is

not entirely clear, but the silicification of the limestone and deposition of the cinnabar probably took place at no great depth and through the agency of hot solutions, possibly hot springs. The mineralization was probably related to the general igneous activity of which the intrusion of the rhyolite porphyry and the extravasation of the Tertiary volcanic rocks of the Thunder Mountain area were manifestations.

CLAIMS OF FERN QUICKSILVER MINING CO.

The Fern Quicksilver Mining Co. owns a group of claims at the head of Fern Creek, extending northward into the drainage basin of Cinnabar Creek. A claim map is shown in figure 2. This company has been most active in developing the deposits and has erected a 12-retort Johnson-McKay furnace capable of treating about 2 tons of ore a day.

The main workings of the company are on the north side of Fern Creek and consist of three short tunnels. The best showing of ore is in the northwest tunnel, which is about 100 feet long and runs about N. 28° E. It is mostly in white marble that carries streaks of iron-stained friable marble and veinlets of hard chalcedonic silica. The silica veinlets make the best ore, but the iron-stained marble also carries cinnabar. The ore seams are irregular and are mostly less than a foot across, rarely 5 feet. About 20 feet to the east another tunnel is driven about 40 feet and exposes similar material. On the surface there is little evidence of extensive silicification in the limestone. About 30 feet northwest of the portal of the main tunnel there is a dike of rhyolite porphyry 100 feet across, and its strike is such that it should be cut by the tunnel not far from the present face. A large limestone cave near the face of the main tunnel was partly filled with loose blocks of good ore. The good ore taken out in driving these tunnels and from the blocks in the cave was run through the furnace and yielded an average of about 2 per cent of quicksilver, in all about 14 flasks up to August 26, 1918. In addition 5 flasks were produced in 1917 from float.

A tunnel about 60 feet lower on the slopes and to the south is driven about 90 feet but shows no ore. This tunnel is driven in rhyolite porphyry near the portal, quartzite farther in, and marble near the face. The quartzite and marble are separated by a streak of white gouge, but there is no evidence of ore in this tunnel.

The course of the ore horizon seems to be across the bedding of the marble, but it is probable that the main ore horizon is along the bedding of the marble and near the contact with the quartzite. No large body of ore was shown at the time of the writers' visits, nor did there appear to be a large body of silicified, mineralized marble.

CLAIMS OF YELLOW PINE QUICKSILVER CO.

The Yellow Pine Quicksilver Co. owns the Bucks Bed claim and a claim and fraction to the east of the Fern mine. Its main showing is on an outcrop of silicified limestone on the east edge of the Bucks Bed claim, about 2,000 feet east of the Fern workings. Little work had been done at the time of the writers' visit, and the form and character of the deposit had to be interpreted largely from natural outcrops. The deposit appears in the outcrop to be an irregular to rudely lenticular body of silicified limestone 250 feet or so in length and about 60 feet across at its widest part. Its length is approximately parallel to the bedding of the marble, and it appears to be near the southwest contact of a thick limestone with quartzite. The beds strike about N. 50° W. and are nearly vertical. Much of this lens is more or less porous to honeycombed iron-stained chalcedonic silica, and this material grades into marble with irregular seams of silica and finally into comparatively fresh marble. Much of the marble in the silicified zone is friable. On the surface little cinnabar is seen, but several shallow cuts show more or less cinnabar and some limonite derived from pyrites. The cinnabar is chiefly in the porous silica, but in places it is in the iron-stained marble, especially where silica streaks are present; rarely cinnabar was seen in the white marble. The lens of silicified rock appears to be irregular, and it includes bodies of little-altered marble. The widest part of the outcrop of silicified limestone appears to be near the east border of the Bucks Bed claim, and the company had started a tunnel to crosscut this lens at about its widest part. A few hundred feet west of the main lens of silicified limestone and at about the same horizon in the limestones are one or more smaller lenslike outcrops similar to that of the main outcrop. These silicified bodies appear to be near the quartzite contact and at about the same horizon in the limestone as the Fern ore body. Other bodies of silicified rock that carry cinnabar are present between the workings of the two companies.

CLAIMS OF IDAHO QUICKSILVER MINING CO.

The Idaho Quicksilver Mining Co. owns seven claims just east of the Bucks Bed claim and the large silicified lens of the Bucks Bed continues eastward into the Idaho Co.'s ground, although it appears to narrow rather rapidly in that direction. Little work has been done on these claims, but a cut near the west-end line shows considerable silicified marble and some friable iron-stained marble with some cinnabar.

ABSTEIN CLAIMS.

H. T. Abstein's claims are still farther to the east and appear to be in a limestone bed that lies more to the north. The claims have

only a few shallow pits, and most of the cinnabar found up to the time of visit was float, but some cinnabar was shown in place in one of the pits.

CLAIMS OF MONUMENTAL MERCURY MINES CO.

The Monumental Mercury Mines Co. has 10 claims in the drainage basin of Cinnabar Creek, bonded and leased from Pringle Smith. At the end of August, 1918, the company had 12 screw-top retorts, each capable of holding 14 pounds of ore and of carrying three charges a day. The company planned to increase this equipment immediately to 52 retorts and to treat about a ton of 2 per cent ore a day. The main workings are on the Hermes claim, just west of Cinnabar Creek and about a mile north of the Fern workings; they are along the south contact of a layer of limestone that is about 150 feet thick. The upper workings are on the Pretty Maid claim and are about 1,500 feet northwest of the lower workings, near the north contact of the limestone layer. The lower or southeastern body has been most prospected. It is at the limestone-quartzite contact, and the zone of brecciation carrying some cinnabar is 20 feet or more across and can be followed for about 200 feet along the strike. Where prospected it includes brecciated quartzite and brecciated silicified limestone and carries more or less cinnabar throughout, partly in seams and partly disseminated. Much of the material is soft and wet and requires close timbering. There are some streaks and veinlets of very good ore, notably a small exposure near the portal of the upper tunnel which shows a seam of fine ore that is as much as 2 feet wide but can be followed for only a short distance along the strike.

The workings about 1,500 feet to the northwest are on a body of silicified rock in the limestone that is elongated parallel to the bedding of the limestone and is 60 feet across at its widest part and is exposed for about 100 feet. It is covered by talus at both ends but is probably lenticular in outcrop. It is made up of iron-stained chalcedonic silica and more or less limestone, much seamed by silica veinlets. It shows little cinnabar on the outcrop but is reported to carry some cinnabar throughout and to have a 3-foot band of very good ore. Just north of this is a body of rhyolite porphyry.

Other prospects to the southeast along this northeast contact of the limestone show some cinnabar.

Some have regarded the two main ore bodies on the Smith property as a single vein, but this conclusion does not seem to be justified, as both bodies appear to be irregular and lenslike or chimney-like replacement deposits, and they are on the opposite contacts of a limestone layer that is about 150 feet thick.

SUMMARY AND CONCLUSIONS.

The Yellow Pine cinnabar district is in Valley County, Idaho, about 70 miles by a poor mountain road from Cascade, Idaho. The active prospects are included in an area of about a square mile.

The deposits are in a body of sedimentary rocks made up of quartzite, limestone, and subordinate schist only a few square miles in extent and surrounded by a great body of granodiorite. Tertiary andesite lavas overlie the sediments and granodiorite only a mile or so from the cinnabar prospects, and numerous dikes and less regular bodies of rhyolite porphyry intrude the sediments and the granodiorite.

The cinnabar deposits are in the limestones or in the sediments immediately adjoining the limestones, and for the most part they are very near the contact between the limestones and quartzites. The deposits covered by the claims of the Fern Quicksilver Mining Co., the Yellow Pine Quicksilver Co., and the Idaho Quicksilver Mines Co. are on Fern Creek, near the south contact of a thick layer of limestone. The workings of H. T. Abstein are higher up in this limestone layer. The deposits covered by the claims of the Monumental Mercury Mining Co. are in a limestone layer only about 150 feet thick and about a mile north of the limestone in which the other deposits are located. The lower workings on this group of claims are along the south contact of this limestone, but the upper workings are along the north contact.

The ore bodies appear to be irregular lenses or chimneys of silicification in the limestone, and the ore is in part the chalcedonic silica and in part the friable marble that adjoins the silica bodies. Cinnabar appears to be the chief sulphide in the ore, but some pyrite is present and more may be found at greater depth. Stibnite is present in the district and is associated with some cinnabar, but it was not observed in the cinnabar ores.

The district has not been sufficiently prospected to justify any definite prediction as to the future outlook, but some good ore is shown, and the cinnabar is distributed over a considerable area. As yet no ore bodies that can be considered large are shown, but some of the bodies of altered silicified limestone appear to be large, and further exploration may expose ore bodies of considerable size.