ANTIMONY AND QUICKSILVER DEPOSITS IN THE YELLOW PINE DISTRICT, IDAHO

By FRANK C. SCHRADER and CLYDE P. ROSS

INTRODUCTION

SCOPE OF THE WORK

The antimony and quicksilver deposits of the Yellow Pine district have been described by Bell,[1] Thomson,[2] Livingston,[3] Larsen,[4] and others. All the geologic work so far done has been of reconnaissance character, but the authors cited have brought out the broader features of the general geology and of the ore deposits, which, with further improvements in transportation and with increased demand, are likely to become of commercial value. The present report is intended primarily to bring the data on mine development up to date. Mr. Schrader made a brief visit to the Yellow Pine district in July, 1923, to examine the antimony deposits, and Mr. Ross spent four days in the district in 1924 examining the quicksilver deposits, as renewed interest in quicksilver resulting from the development of the Emmet mercury boiler and turbine made it advisable to acquire up-to-date information on such a possible future source of supply.

The writers are indebted to Messrs. Albert Hennessy and G. B. Kennedy, residents of the district, for aid and information in the field, and to Mr. J. J. Oberbillig, manager of the United Mercury Mines Co., for similar help and for mine maps and other data.

LOCATION AND MEANS OF ACCESS

The Yellow Pine district (fig. 5) is about 100 miles northeast of Boise, near the center of Valley County, in the midst of the little-developed mountainous region of central Idaho. Yellow Pine, a small settlement and post office in the northwestern part of the district, is most conveniently reached from Cascade, a thriving lumber town on the Long Valley branch of the Oregon Short Line, by the automobile road recently completed by the United States Forest

[1] Bell, R. N., Twentieth annual report of the mining industry of Idaho for the year 1918, pp. 97, 99, 1919; Quicksilver and antimony discoveries in central Idaho: Idaho Min. Dept. Bull. 1, 12 pp., 1918.

[2] Thomson, F. A., Notes on the antimony deposits of Idaho: Idaho Univ. School of Mines Bull. 2, vol. 14, pp. 49-52, 1919.

[3] Livingston, D. C., Tungsten, cinnabar, manganese, and tin deposits of Idaho: Idem, pp. 54-65.

[4] Larsen, E. S., and Livingston, D. C., Geology of the Yellow Pine cinnabar mining district, Idaho, U. S. Geol. Survey Bull. 715, pp. 73-83, 1920.

Service. The distance is about 65 miles. Yellow Pine is a little over 20 miles west of the site of the old town of Roosevelt, the former center of the Thunder Mountain gold-mining district. From the

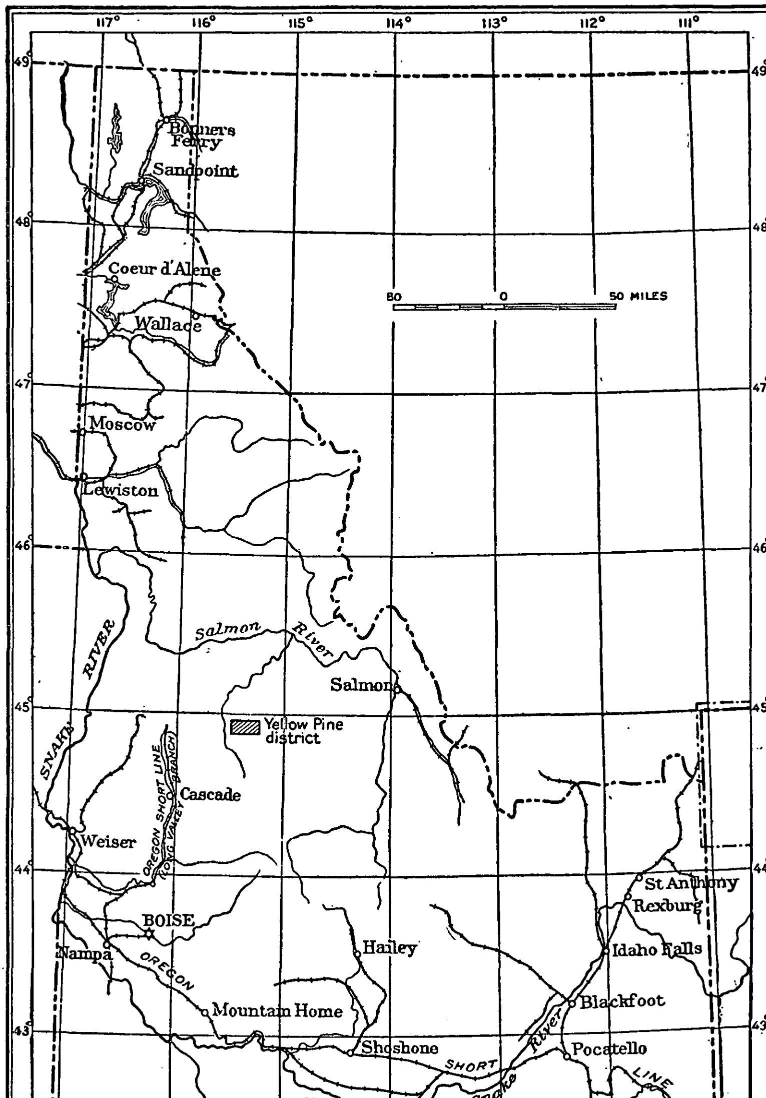


FIGURE 5.—Index map of Idaho showing location of Yellow Pine mining district

vicinity of Yellow Pine several trails lead eastward to the mines and prospects shown in Figure 6. The shortest trail to the quicksilver deposits leaves the road near the Johnson Creek ranger station, about

4 miles south of Yellow Pine, crosses the high mountains to Meadow Creek, and is about 16 miles long. The old Thunder Mountain road passes within 2 miles of the camp of the United Mercury Mines Co. and is connected with it by a trail. Machinery and supplies for this and other properties in the district have been brought in over this road, but it is reported to be in poor repair and to have such steep grades as to be an impracticable route for regular traffic. A more suitable route for a road would probably be up the East Fork from Yellow Pine along one of the present trails.[4a] Such a road would have about the same grade as the stream, approximately 3 per cent most of the way, but would be expensive to construct because of the large amount of excavation in solid rock that would be necessary.

SUMMARY OF RESULTS

The Yellow Pine district contains deposits of antimony, quicksilver, and other metals. The antimony ore is principally in lodes in granitic rocks and the quicksilver in replacement deposits in limestone. The production of antimony so far has been small, and only about 45 flasks of 75 pounds each of quicksilver had been produced up to the end of 1924. This small output is a result of the inaccessibility of the region and lack of adequate development and is no indication of the potential value of the deposits. The showings so far made are sufficiently favorable to justify considerable further development, and a number of the prospects give promise of developing into valuable mines.

TOPOGRAPHY

The topography of the Yellow Pine district is that characteristic of central Idaho, a deeply dissected mountain mass covered with a fairly heavy growth of pine, spruce, and fir. The slopes in general are smooth and steep but are broken here and there by cliffs. The maximum relief is of the order of 4,000 feet, and the highest peaks reach altitudes of about 9,000 feet above sea level. The summits of several of the mountains are capped by gently undulating areas, many of which accord with one another in a general level at an altitude of about 8,500 feet, denoting that the present topography has been carved from an ancient uplifted peneplain or plateau, as described by Umpleby[5] and others in reports on surrounding regions. The district is drained by the East Fork of the South Fork of Salmon River (hereinafter called the East Fork), which in general flows westward. Above Yellow Pine this stream has a narrow flood plain bounded by cliffs at short intervals. The valley of Johnson Creek,

[4a] It is reported that a survey was made in 1925 for a road from Yellow Pine up East Fork and thence to Profile.

[5] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, p. 25, 1913.

its chief tributary, is more open and contains some farming land. Johnson Creek flows south and enters East Fork at Yellow Pine.

The habitations in the district consist of about eight ranch cabins dotting the lower 10 miles of the valley of Johnson Creek, including the few at Yellow Pine, and the prospector's cabins and mine buildings in the eastern part of the district, including the cabins, boarding house, and mill on the Hermes group and cabins at the Fern, Doris K., and Meadow Creek workings. The Meadow Creek cabin serves as a hospitable road house to the wayfarer.

The principal available maps covering the district and the surrounding region are the map of the Payette National Forest, edition of 1924, and the General Land Office map of the State. Detailed blue-print hachured maps of Tps. 18 and 19 N., R. 8 E. Boise meridian, on a scale of 2 inches to the mile, are obtainable from the General Land Office at Boise, Idaho, or Washington, D. C. These maps cover the lower 8 miles of the valley of Johnson Creek and extend 4 miles north of its mouth at Yellow Pine. In addition part of the region is shown on the geologic and topographic sketch map by Larsen and Livingston [6] and the similar map by Livingston.[7] A map showing part of the cinnabar claims is included in Livingston's report.

The last three maps above mentioned, data supplied by the United Mercury Mines Co., and observations by the present writers were used in the compilation of Plate XVIII, on which the local geology is represented approximately. This map can not be relied on for such details as the exact relation between claim lines and geologic boundaries.

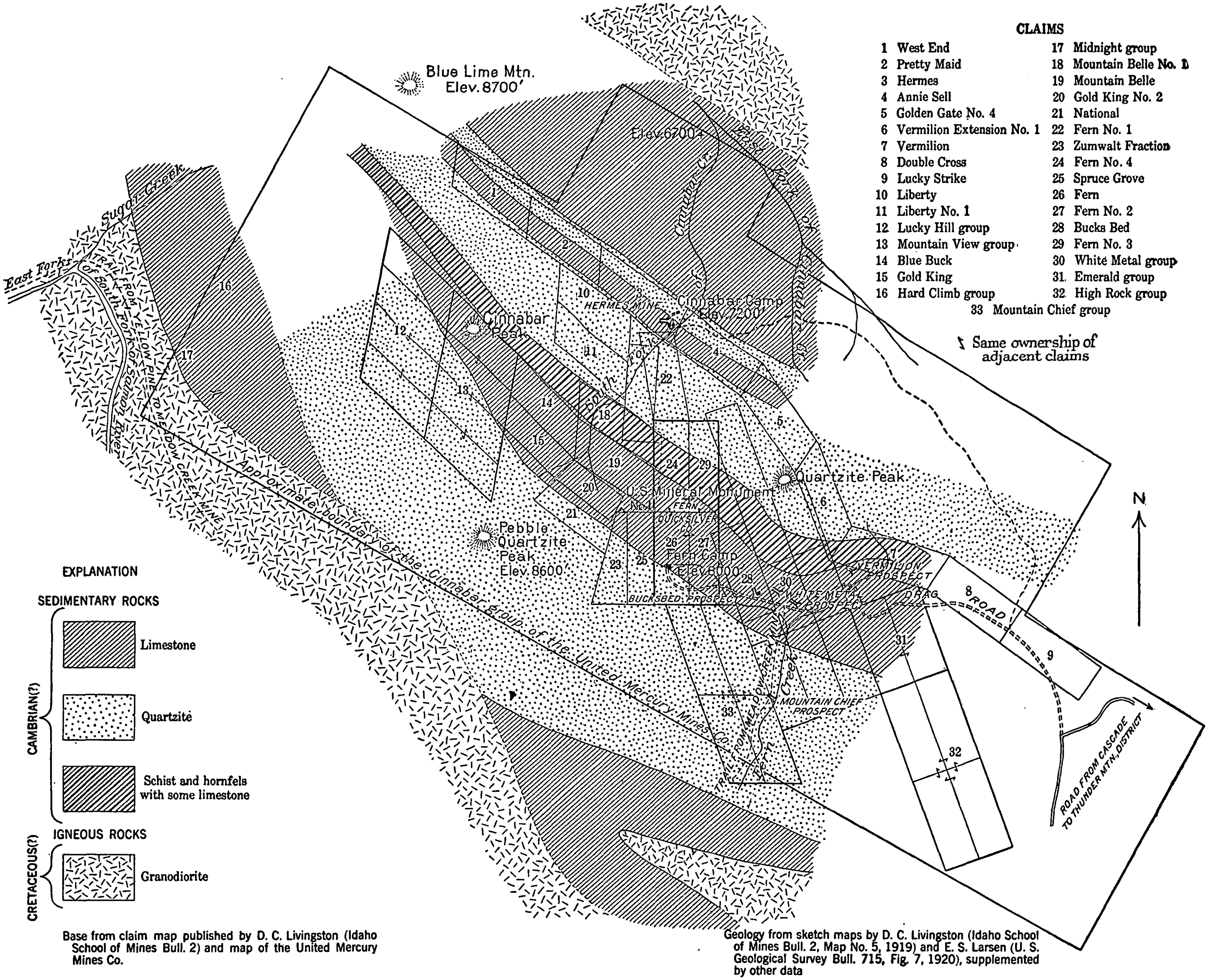
GEOLOGY

The greater part of the district (see fig. 6) is underlain by granitic rocks of the Idaho batholith, believed to be of Cretaceous age. These rocks contain the antimony deposits. Tertiary volcanic rocks consisting of lava and tuff are present near the eastern border of the district and cover an extensive area to the east of it. A northwest-southeast belt of metamorphosed sedimentary rocks, which appears to be a large roof pendant in the batholith and owes its metamorphism to the intrusion of the granitic rocks, crosses the east-central part of the district and continues northwestward.

SEDIMENTARY ROCKS

The belt of sedimentary rocks is about 2 miles wide, and Bell [8] estimated that it was 3 or 4 miles long, but according to local report it extends for 6 miles or more.

[6] Larsen, E. S., and Livingston, D. C., op. cit., fig. 7.
[7] Livingston, D. C., op. cit., map 5.
[8] Bell, R. N., Twentieth annual report of the mining industry of Idaho, for the year 1918, p. 92.



SKETCH GEOLOGIC AND CLAIM MAP OF THE QUICKSILVER DEPOSITS IN THE YELLOW PINE MINING DISTRICT, VALLEY COUNTY, IDAHO

0 1,000 2,000 3,000 4,000 5,000 FEET

On the west side of the belt, along East Fork, is a gray thick-bedded quartzite with low undulating dip, supposed to be of pre-Cambrian age. In the exposures near the mouth of Salt Creek this rock is rather coarsely crystalline and shows little evidence of bedding. It contains sparsely disseminated flakes of glistening black mica and a few grains of plagioclase feldspar. Farther down East Fork the quartzite breaks in thin plates and is composed of quartz and biotite. Similar rocks in the upper part of the drainage basin of Big Creek, about 10 miles to the north, have been described by Umpleby and Livingston.[9] The slate associated with the quartzite in that region is reported by them to resemble the Prichard slate of the Belt series, and the thick series of quartzite, slate, and schist there exposed is assumed by them to be of pre-Cambrian age.

Farther east are alternating beds of quartzite, limestone, and argillaceous rocks (Pl. XVIII), believed to be of Paleozoic and perhaps Cambrian age. Most of the cinnabar deposits are in limestone beds in this series. The series is steeply tilted and differs strikingly in this respect and in lithology from the pre-Cambrian (?) quartzite. The relations between the two have not been determined, but it appears to be a general rule in Idaho that the pre-Cambrian beds, which are predominantly quartzitic, are less highly folded than the Paleozoic beds, which consist of alternating quartzite, limestone, and argillaceous rocks. The highly tilted rocks in the vicinity of the cinnabar deposits have been briefly described by Livingston [10] and Larsen,[11] but more detailed work is necessary before an accurate stratigraphic section can be made of rocks so highly disturbed and metamorphosed in a country so rugged and well timbered. Plate XVIII is based on the work of Larsen and Livingston, supplemented by that of Ross. The best exposures are on the ridge west of the south fork of Cinnabar Creek. The general strike along this ridge is about N. 65° W. and the dip is steep to the southwest, but near the headwaters of the fork the strike is locally more northward and the dip northeastward.

North of Cinnabar Camp the rock is principally limestone with some schist, which includes the Kennedy "mica ledge" (prospect No. 10, fig. 6) on Sugar Creek. This ledge where crossed by the trail on the north side of the creek is 50 feet wide and has a pronounced nearly vertical schistosity modified by small sharp wrinkles and contortions. It is gray where fresh and bronzy or pale rusty brown with a silvery sheen where weathered. It consists of minute scales of impure muscovite with quartz, garnet, and fine-grained ferruginous

[9] Umpleby, J. B., and Livingston, D. C., A reconnaissance in south central Idaho: Idaho Bur. Mines and Geology Bull. 3, p. 2, 1920.

[10] Livingston, D. C., op. cit., pp. 59-60.

[11] Larsen, E. S., and Livingston, D. C., op. cit., pp. 76-78.

material. It has been prospected for mica but is too fine grained and impure to be of commercial value.

South of the limestone and schist is a rather impure quartzite with some slate, and south of this is the limestone containing the deposits of the Hermes mine. This limestone is about 300 feet thick and contains beds of quartzite and schist. This rock is bordered on the south by a narrow zone of schist and hornfels interbedded with metamorphosed limestone. It grades southwestward into marbleized limestone. The composite rock of this narrow zone is in places distinctly banded, and the component bands are less than an inch thick, but where hornfels is the dominant or only variety present it is less distinctly banded. The banding is probably parallel to the bedding and shows much contortion. Larsen [12] found that the hornfels contains quartz, orthoclase, diopside, tremolite, carbonates, more or less phlogopite, epidote, titanite, magnetite, apatite, and a scapolite (near wernerite). The marbleized limestone is in part dolomitic and contains much tremolite and other lime silicates. It also contains masses of jasperoid, in which cinnabar is reported to have been found. The Fern and Bucksbed deposits are in the middle part of this limestone, and the Vermilion deposits are along its northeast border. The ridge at the head of Cinnabar Creek is composed of a broad belt of quartzite, in part banded. The beds near both sides of this belt are conglomerate, composed of moderately well rounded quartzose pebbles in a quartzite matrix. The next unit southwest of this quartzite consists largely of impure and metamorphosed limestone interrupted by intrusive granodiorite. Near the Mountain Chief prospect banded hornfels like that on Cinnabar Creek is present, but its exact relations to the quartzite are concealed by detritus.

In a broad way these sedimentary rocks bear a stronger lithologic resemblance to beds of Cambrian (?) and Ordovician age in the Lemhi Range and neighboring mountains [13] and to parts of two formations of the Wood River region,[14] which are supposed to be of Cambrian age, than to any other known rocks in central Idaho. The hornfels in the vicinity of the quicksilver deposits shows a striking resemblance to hornfels in one of these formations in the Wood River region, which will be described in the paper cited. The resemblance is so close as to suggest that the two should be correlated.

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[12] Larsen, E. S., op. cit., p. 77.

[13] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho; U. S. Geol. Survey Bull. 528, pp. 32-33, 1913; Geology and ore deposits of the Mackay region, Idaho: U. S. Geol. Survey Prof. Paper 97, pp. 23-25, 1917. Ross, C. P., Copper deposits near Salmon, Idaho: U. S. Geol. Survey Bull. 774, p. 8, 1925.

[14] Westgate, L. G., Umpleby, J. B., and Ross, C. P., Geology and ore deposits of the Wood River region, Idaho: U. S. Geol. Survey Bull. — (in preparation).

IGNEOUS ROCKS

Granitic rocks.—The granitic rocks form a part of a mass which has long been known as the Idaho batholith and which occupies most of central Idaho. So many different varieties of granite rock were noted while passing through the area as to suggest that several distinct intrusive masses may be present, perhaps differing materially in age. Perhaps the so-called Idaho batholith is more complex than might be judged from the available data. A large part of the rock observed is light gray, medium grained, and somewhat porphyritic and has approximately the composition of biotite granodiorite. Pink alkali feldspar is sufficiently abundant in some areas to be the dominant coloring constituent of the rock and to make it a granite or quartz monzonite. The rock exhibits much variation in texture. Large masses on East Fork are strikingly finer grained than most of the rock farther south. The composition also varies markedly. From field examination it appears that granodiorite, quartz monzonite, diorite, and probably other rocks are present. Lamprophyre and aplite dikes occur in and near the Meadow Creek gold mine. Small dikes of aplite and pegmatite are exposed along the trail to that mine from the Johnson Creek ranger station and similar rocks, now much altered, cut the limestone in the Hermes mine. In numerous places along the trail just mentioned small bands and irregular masses in the granitic rock are gneissic, apparently as the result of flowage before the consolidation of the rock was complete. In and near the gneissic masses are numerous small bodies of intensely altered sedimentary rock, principally limestone. Such material is particularly abundant on the ridge at the head of No Man's Creek. In places, especially on the margins of the included bodies, the magma penetrated the sedimentary rock so intimately that it is difficult to distinguish between gneissic igneous rock and metamorphosed limestone.

Tertiary volcanic rocks.—The youngest rocks in the district are lava and tuff, which overlie the granodiorite and presumably also the sedimentary beds along the eastern border of the area shown in Figure 6. Similar rocks extend for 12 miles or more to the east in the Thunder Mountain mining district.[15] According to Larsen,[16] most of the volcanic rocks near the quicksilver deposits are flows and probably have the composition of quartz latite and andesite. By analogy with similar rocks in other parts of Idaho they are believed to be of Tertiary age.

Dikes of rhyolite and andesite cut the sedimentary beds that contain the quicksilver deposits and the adjoining granitic rocks. Some specimens of porphyritic dike rock contain so much plagioclase as

[15] Umpleby, J. B., and Livingston, D. C., A reconnaissance in south-central Idaho: Idaho Bur. Mines and Geology Bull. 3, map 1, 1920.

[16] Larsen, E. S., and Livingston, D. C., op. cit., p. 76.

to resemble quartz latite. These dikes are so similar in composition to the Tertiary lava that they are probably of the same age and closely related to it.

ORE DEPOSITS

Mineral deposits in the Yellow Pine mining district have been worked for quicksilver, gold, and antimony. Silver, copper, lead, and zinc are present but have not been found in commercial quantities. Gold placer mining has been attempted on Fern Creek and elsewhere, but apparently with little success.

The prospects visited are listed below, and their locations are shown by corresponding numbers in Figure 6. With the exception of the Meadow Creek gold mine, the Golden Gate and Copper King veins, and the Kennedy "mica ledge," these prospects have been opened for antimony or quicksilver.

Mines and prospects in the Yellow Pine mining district

Antimony:
- 1. Babbitt Metal mine.
- 2. Silver Cliff lode.
- 3. Golden Gate vein.
- 4. Copper King vein.
- 6, 7. Hennessy lode.
- 8. No Name ledge.
- 9. Bonanza ledge.
- 11. Doris K. prospect.
- 12. Doris K. No. 3 prospect.

Miscellaneous:
- 5. Meadow Creek gold mine.
- 10. Kennedy "mica ledge."

Quicksilver:
- 13. Hermes mine.
- 14. Silver Bow lode.
- 15. Vermilion lode.
- 16. White metal ledge.
- 17. Buckbed lode.
- 18. Fern mine.
- 19. Mountain Chief ledge.
- 20. Midnight ledge.
- 21. Hard Climb ledge.

ANTIMONY DEPOSITS

By F. C. Schrader

GENERAL FEATURES

The antimony deposits occur mostly in the granitic rocks, notably the granodiorite. The antimony mineral, stibnite, is associated chiefly with quartz in veins or other bodies, which fill faults or shear zones and are usually associated with pegmatite and aplite or alaskite dikes or with complementary basic dikes. Some stibnite is disseminated in the adjacent wall rocks. This mode of occurrence is similar to that in many antimony deposits found elsewhere. The stibnite is usually accompanied by gold or silver, or both, as a rule in commercial quantities. The objectionable metals, copper, lead, and zinc, are present in too small quantity to affect the ore appreciably, and bismuth and arsenic are absent. Some of the deposits contain a little cinnabar. The stibnite is mostly well crystallized and of medium grain, but it ranges from coarsely crystalline, as in

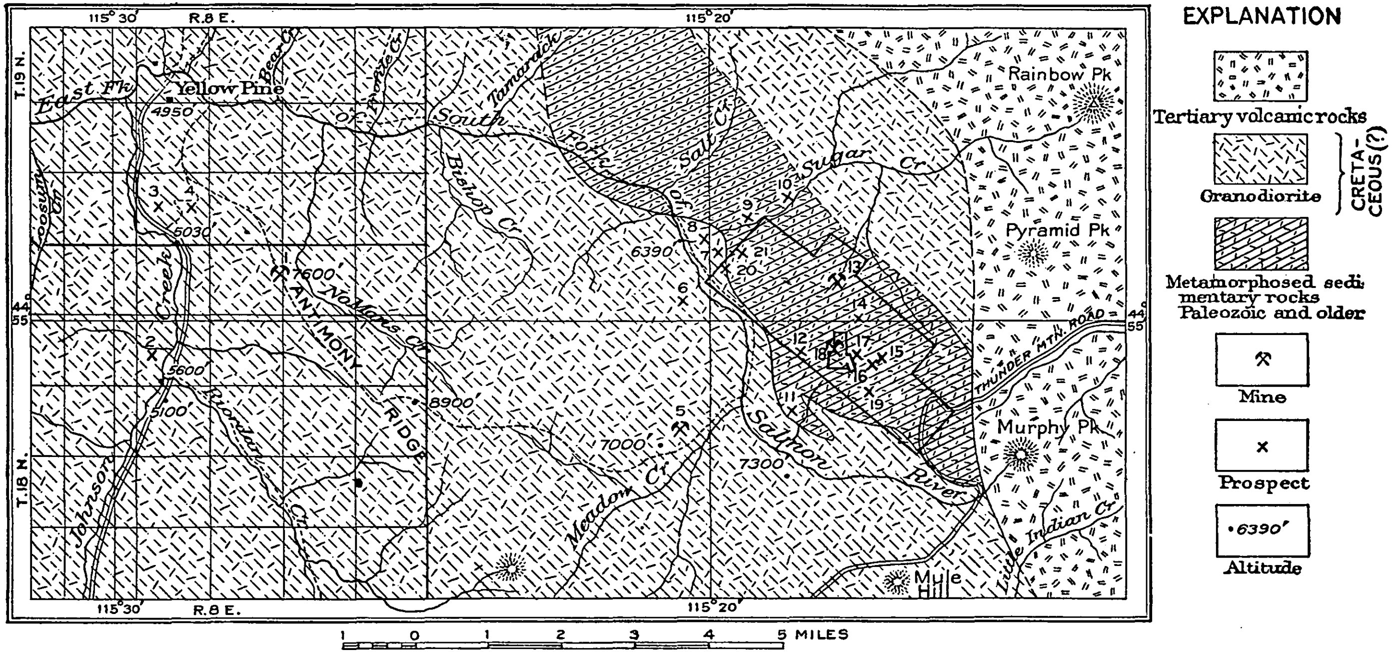

FIGURE 6.—Geologic sketch map of the Yellow Pine mining district, Valley County, Idaho, showing location of ore deposits. Base from United States Forest Service map of Payette National Forest, 1924. Approximate positions of mines and prospects and outlines of groups of cinnabar claims added by Frank C. Schrader and Clyde P. Ross. Larger outline indicates Cinnabar group of United Mercury Mines Co., smaller outline, property of Fern Quicksilver Mining Co. Geology compiled by Clyde P. Ross from field observations supplemented by data furnished by J. J. Oberbillig and by the geologic map of the district by E. S. Larsen and D. C. Livingston (U. S. Geol. Survey Bull. 715, fig. 7, 1920). The numbers refer to the list of mines and prospects on page 144.

the Babbitt Metal mine, to fine grained or aphanitic. The fine-grained material occurs mostly in the low-grade deposits.

ORIGIN

The mode of occurrence of these deposits is similar to that of antimony deposits at many other places in the world, and there is therefore good reason for believing that they are genetically connected with the intrusive granitic rocks. This belief has also been expressed by Thomson.[17] On the other hand, from the occurrence of a little cinnabar in association with some of the antimony deposits near the cinnabar deposits on the east and the association of a little stibnite with some of the cinnabar deposits, Larsen and Livingston [18] regard the origin of the deposits of both types as connected with that of the Tertiary volcanic rocks east of Cinnabar Camp. The question is further discussed by Mr. Ross on pages 157–159, but no definite conclusion is justified by the evidence at hand.

The antimony deposits on the whole are promising and contain considerable antimony, but in most of the larger ones the ore is of low grade and must be concentrated. Some of the deposits can probably be most profitably worked primarily for gold or silver, with antimony as a by-product. Though the antimony deposits in general do not extend to great depths, it may be noted that the Meadow Creek workings are reported to be in good ore at depths of about 500 feet, with no indication that the lower limits of the ore have been reached. The deposits have been opened at ten prospects or mines, from one of which, the Babbitt Metal mine, a small production was made during the World War under very adverse conditions of transportation. The deposits occur in two main areas—the Johnson Creek area, in the northwestern part of the district, and the Meadow Creek-Sugar Creek area, adjoining the cinnabar deposits in the eastern part of the district.

MINES AND PROSPECTS

JOHNSON CREEK AREA

BABBITT METAL MINE

The Babbitt Metal mine, formerly known as the Yellow Pine and also as the Hanson antimony mine, is in the eastern part of the area 3 miles southeast of Yellow Pine. (See fig. 6, mine No. 1.) It is about 1½ miles northeast of the Johnson Creek forest-ranger station, at an altitude 2,000 feet higher. The country rock is the granodiorite described on page 143, and the deposits are associated with

[17] Thomson, F. A., op. cit., p. 49.

[18] Larsen, E. S., and Livingston, D. C., op. cit., pp. 79, 80, 83.

the pegmatitic dikes, the principal gangue mineral being vein quartz. The deposits here and those west of Johnson Creek have been described by Thomson.[19]

The deposits occur in the upper part of the prominent ridge known as Antimony Ridge, which separates Johnson Creek from No Man's Creek. They are very favorably located for mining by tunneling and stoping from the surface. They have been referred to as the "east side deposits" and as the Hanson vein.

The deposits were known as far back as 1875, but the early prospectors thought that they were lead deposits and that the stibnite was galena. During the World War the deposits were sold by C. G. Hanson, of Yellow Pine, to the Idaho Mining Co., of Seattle. This company developed them and is said to have mined 110 tons of ore in 1916–17. Of this ore 40 tons were shipped to Chicago when the price of antimony was 40 cents a pound, and most of the rest still lies on the dump at the mine. The deposits were later leased to the Nowak Co., of Chicago, which put up a small mill for treating the ore at the foot of the mountain, near the ranger station. Though the process used is said to have yielded a very high percentage of metal extraction experimentally on a small scale, it was not a commercial success. This, however, is seemingly no fault of the ore. The plant was later dismantled and moved to the Hennessy ranch, near by, where it is to be improved, and the metallurgical experiments are to be continued. A road is reported to have been built from Johnson Creek to the mine in the summer of 1925.

The deposits are now owned by the United Mercury Mines Co., of Boise, Idaho. The property comprises a group of six claims known as the Babbitt Metal group. It extends southwestward across Johnson Creek to the Silver Cliff property on the west. Babbitt Nos. 1 and 2 claims, on the east, contain most of the workings. (See fig. 6.)

The deposits are traceable for a distance of 4,000 feet horizontally across Antimony Ridge, lying mostly on its west slope between altitudes of 7,100 feet (on the west) and 7,600 feet (at the top of the ridge). They seem to extend through the ridge, at least to depth corresponding approximately with their lowest outcrops and workings, and to contain a considerable quantity of high-grade commercial ore. The oxidation zone is very thin, and the stibnite generally begins at or within a foot or two of the surface.

The zone of mineralization or lode is regarded as 200 feet in width by former operators, but the deposits apparently consist essentially of a single quartz-stibnite vein, which, as seen on the west slope, is offset by transverse faults at several points, as shown in Figure 7.

[19] Thomson, F. A., op. cit., pp. 49–52.

The vein strikes N. 40° E. and dips 75° SE. It is locally about 20 feet in maximum width and is opened at several points by shallow workings, mostly by cuts and short tunnels on the west slope and by a 75-foot adit at about 60 feet below the top of the ridge on the east slope.

The vein commonly shows from 6 to 18 inches of clean, workable stibnite. At one point there is a lens of stibnite 30 feet long with a maximum width of 5 feet. The main adit workings on the east side contain a 2-foot and 3-foot vein of fairly pure stibnite, and at 300 feet below the mouth of the tunnel the vein is said to expose a shoot of pure stibnite 6 feet wide. Though the ore shoots are nearly all in the vein or fissure, some ore occurs also as replacement deposits in

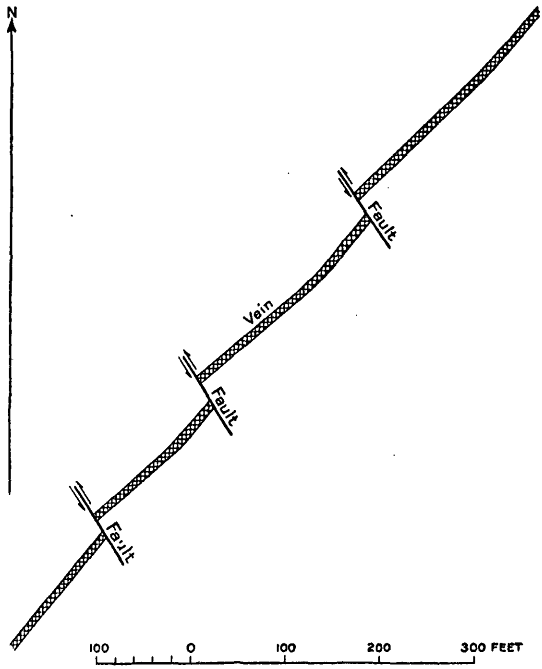

FIGURE 7.—Diagram showing offset faulting of Babbitt Metal vein, Yellow Pine district, Idaho

the adjoining granodiorite wall rock. Thomson [20] reports having found also small specks of disseminated stibnite constituting more than 0.5 per cent of the granodiorite, suggesting that its occurrence there may be primary.

The ore on the whole is said to average about 50 per cent of antimony, and some of it assays about $15 in gold and silver to the ton. Analyses of samples of the ore taken across portions of the vein by Thomson are reported to have averaged about 42 per cent of antimony, 2½ ounces in silver to the ton, and a trace of gold.[21]

[20] Thomson, F. A., op. cit., p. 51.

[21] Idem, p. 51.

The stibnite in general is well crystallized and mostly of medium grain, though some is fine grained. In some specimens the crystals are finely striated by multiple twinning. Some prismatic crystals present faces 1½ inches long by 1 inch wide. Specimens of the ore, including 1 specimen weighing 17 pounds, are on exhibit in the mineralogical collection of the United States National Museum.

SILVER CLIFF LODE

The Silver Cliff lode, which includes the "west side deposits," is 3 miles south of Yellow Pine on the west side of Johnson Creek and 2 miles southwest by west of the Babbitt Metal mine. (See fig. 6, prospect 2.) The country rock is granodiorite, and the deposits consist largely of a north-south siliceous mineralized zone about 1,200 feet wide and a mile or more long, trending about parallel with Johnson Creek and rising from 300 to nearly 1,100 feet above it. On the east the zone breaks off in a cliff several hundred feet high, which probably represents a fault zone. As exposed mainly in the cliff, the mineralized zone is composed chiefly of a fine-grained monzonitic aplite or altered granitic rock, locally called "quartzite." It is more or less seamed with small quartz veins and stringers and contains sporadically distributed bodies and small veins or stringers of stibnite a foot or more in maximum diameter. The dominant shapes of the bodies are flattish or tabular—for example, on two facing and nearly contiguous joint-plane faces were observed two replacement slabs of stibnite, each from half an inch to nearly 2 inches in thickness and extending for more than a foot along the exposed edge of the planes. At the foot of the cliff boulders as much as 5 feet in diameter dislodged from the parent ledge are nearly one-fourth stibnite. The stibnite shows some well-crystallized material of medium grain and some profusely laminated or bladelike crystals nearly 2 inches long, most of them with interstitial fine granular stibnite.

The western margin of the zone lies in a parallel gulch which, being concealed by vegetation, could not be examined in the present work. The nearest exposure of fresh granodiorite was found in the west side of this gulch, toward the north end of the Silver Cliff property.

Most of the deposits are owned by Albert Hennessy, whose holdings consist of the Silver Cliff group of 6 contiguous claims extending in double file for a length of 4,500 feet on the deposits. The deposits have been prospected principally by an 80-foot tunnel near the middle of the southern half of the property and a few pits representing assessment work toward the north. The tunnel trends west of north, parallel with the sheeting in the granodiorite, which dips 70° E., toward the creek.

At the time of the writer's visit the tunnel showed chiefly mineralized granitic rock with disseminated pyrite and a little stibnite and stain of antimony oxide. The mineralization varies from place to place. The rule seems to be the more pyrite the less antimony and vice versa. Some of the deposits are said to assay about $20 in silver to the ton. Analyses of representative samples of the deposits, however, are said to have yielded 4.2 per cent of antimony and only a trace of silver.[22]

The deposits seem to be replacement deposits in the aplite and probably owe their origin to solutions that followed this or some other intrusive rock, perhaps the pegmatite that is associated with the Babbitt Metal deposits. They are large deposits of low grade, and in this respect are in marked contrast with the Babbitt Metal deposits. Although no body of commercial value is yet in sight, they doubtless contain a large quantity of antimony and seem well worthy of exploration to ascertain whether they can be profitably worked on a large scale. As shown in the face of the cliff the deposits extend to a depth of several hundred feet, but they probably do not extend very much deeper. Some of the residents claim that where the veins are dissected by deep gulches or canyons the antimony shows a decrease in quantity with depth and is finally replaced by gold-silver ore, copper ore, or merely pyrite.

From the Silver Cliff property southward the zone of mineralization, as shown by discoloration of the rocks rising to an altitude of about 7,200 feet, extends with considerable regularity up Johnson Creek for several miles, but it could not be examined in detail in the present work. Its general appearance suggests that it may be a promising field for prospecting.

NORTHERN DEPOSITS

To the north of the Silver Cliff property the course of Johnson Creek makes an offset of half a mile to the west (fig. 6), beyond which, approximately on the projected strike of the Silver Cliff lode, occur two prominent quartz veins, the Golden Gate and Copper King (Nos. 3 and 4, fig. 6), associated with altered rock, which collectively may represent the northward continuation of the Silver Cliff zone of mineralization. For convenience these veins are here referred to as the northern deposits.

The veins lie in granodiorite. They are about a quarter of a mile apart, and they cut through a prominent spur descending from Antimony Ridge on the east, in whose south slope their outcrops and the workings show a vertical range of nearly 900 feet. The veins strike about N. 20° E. and are said to extend about 2 miles northward and to be crosscut by East Fork to the east of Yellow Pine.

[22] Thomson, F. A., op. cit., p. 51.

COPPER KING VEIN

The Copper King vein, owned by G. B. Kennedy, is about 6 feet wide and dips 80° E. Its course is well marked by a line of resistant outcrops that form a ridge which stands in places 10 feet or more abruptly above the adjacent surface and which is conspicuous from points several miles distant. The vein and fissure are remarkably well defined, with clean-cut, firm, smooth walls. The vein is said to average about $9 in gold and silver to the ton and about 1.5 per cent of copper, and it contains a little stibnite. It is opened at several points on the south slope of the ridge, chiefly by a 250-foot tunnel at an altitude of about 6,200 feet in which the vein shows pyrite disseminated throughout the quartz gangue.

GOLDEN GATE VEIN

The Golden Gate vein lies about a quarter of a mile west of the Copper King. It is a low-grade deposit somewhat similar to the Silver Cliff lode, from which it differs, however, in containing much more pyrite and seemingly less stibnite. It ranges from 40 to 100 feet in width, and from reported assays it is believed to average about $5 to the ton in gold and silver.

MEADOW CREEK-SUGAR CREEK AREA

The Meadow Creek-Sugar Creek area is in the eastern part of the district, on East Fork. (See fig. 6.) It includes the west end of the high, massive ridge between East Fork on the south and Sugar Creek on the north, known as Cinnabar Ridge. The principal tributaries of East Fork in this area are Sugar Creek and Stibnite Creek, which join East Fork on the northeast, about 3 miles apart, and Meadow Creek, which joins it on the southwest, about 2 miles above Sugar Creek. The altitude at the mouth of Sugar Creek is about 6,300 feet, and at the mouth of Stibnite Creek 7,300 feet. The area is approached from the west by a trail ascending East Fork or over the high mountain to Meadow Creek, as described on page 138. The country rock consists mainly of granodiorite and allied granitic rocks, but on the northeast these rocks are intruded into the sedimentary rocks of Cinnabar Camp, which strike northwest and dip at high angles, for the most part to the southwest.

The antimony deposits, which include several promising prospects, occur chiefly between altitudes of 6,200 and 8,200 feet. They are in or associated with areas of siliceous mineralization in the granitic rocks, in which the chief ore mineral, stibnite, seems to occur mostly in small bodies similar to those in the Silver Cliff lode. To judge from the meager amount or entire lack of development work on most of them, they seem likely to prove more valuable for their silver content, with antimony as a by-product, than for antimony ore alone. One of the more promising of the deposits is the Hennessy lode.

HENNESSY LODE

The Hennessy antimony lode (Nos. 6 and 7, fig. 6), owned by Albert Hennessy, is on East Fork about three-quarters of a mile above the mouth of Sugar Creek. It seems to trend across East Fork and to have an extent of nearly a mile. Where exposed by outcrops and a few small pits on the southwest side of East Fork, the lode shows a width of about 200 feet. It strikes northeast and is cut by a zone of close sheeting. It consists chiefly of silicified granodiorite, some lighter-colored and more siliceous rock, and quartz, in all of which occur irregular masses and tabular bodies of stibnite or dark antimony ore, some of which yield slabs 3 to 4 inches in diameter by an inch in thickness. In this respect the lode is similar to the Silver Cliff deposits above described. Specimens of the ore are reported to have assayed about $100 in gold and $20 in silver to the ton. However, as the specimens came from croppings or from ore near the surface, the high gold content probably represents concentration by oxidation and can not be expected to continue in depth.

On the northeast side of East Fork what seems to be the continuation of the lode is exposed by outcrops and shallow openings about 300 feet above the stream. Here the showings indicate a lode width of at least 100 feet and seem to be more promising for stibnite than those on the south side of the stream. The stibnite is more coarsely crystalline and striated. Granodiorite is present, and heavy quartzite talus indicates the probable presence of quartzite near by up the mountain side.

BONANZA LEDGE

The Bonanza ledge (No. 9, fig. 6), owned by G. B. Kennedy, is exposed on the northwest side of Sugar Creek about a mile above its mouth. It extends from the creek 500 feet northward and rises 300 feet above it in the steep mountain side. It has a known width of 60 feet. It is only slightly prospected but presents good showings in outcrops at several points. The ore is dark gray and consists of finely divided stibnite and pyrite disseminated in crushed granodiorite and quartz. The gangue is harder than in the Hennessy lode.

Specimens of the ore are said to have assayed $20 or more to the ton in gold and silver, about one-fourth in silver. A short distance upstream from the ledge the country rock is quartzite, and it is cut by north-south aplitic dikes with which the ledge is probably genetically connected.

NO NAME LODE

The No Name lode (No. 8, fig. 6) is exposed in the south bluff of Sugar Creek half a mile above its mouth, and from this point it extends southeastward into the mountain side but was not traced far in the present work. It has a width of about 50 feet. The lode consists chiefly of crushed and mineralized medium-grained granodiorite with a longitudinal jointing or shear structure dipping 50° SW. Much of it is friable and honeycombed and preserves the outlines of pyrite crystals, which have been removed by oxidation. It contains finely disseminated stibnite and is said to assay well in gold and silver.

DORIS K. GROUP

The prospects contained in the Doris K. group of claims, owned by the Doris K. Mining Co., of Chicago and Yellow Pine, are in the upper western part of Cinnabar Ridge. The group nearly joins the Fern cinnabar property on the east and is said to have been acquired recently by the United Mercury Mines Co. and included in its ground. The main prospects are the Doris K. and the Doris K. No. 3.

The Doris K. prospect (No. 11, fig. 6) is on the south slope of Cinnabar Ridge, on the northwest side of Stibnite Creek about half a mile from its mouth at East Fork and at an altitude 900 feet higher. It consists mainly of a mineralized zone or lode 100 feet or more wide containing several siliceous veins or ore shoots. It seems to be the deposit that was favorably described by Bell [23] as consisting chiefly of "several large antimony-bearing quartz-breccia veins associated with large porphyry dikes." The outcrops extend through a vertical range of about 300 feet, between altitudes of 7,900 and 8,200 feet, but are mostly contained in an area about 100 feet in diameter at an altitude of about 8,100 feet. The developments at the time of visit consisted mainly of shallow pits and trenches about 10 feet in maximum depth. A tunnel that was being driven northward in the lower slope should tap the lode at a point 250 feet in from the portal and a depth of 200 feet below the surface. The lode seems to trend about N. 25° E.

The location is in the western margin of the sedimentary rock series of Cinnabar Camp, near its contact with the granodiorite. Reddish stained quartzite and medium to coarse granodiorite are associated with the antimony outcrops. A belt of mica schist occurs down the slope between the deposit and the cabin near by on the southeast, and another belt occurs in the neighboring southwest slope at an altitude of about 7,400 feet. Up the slope northward from the deposit

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[23] Bell, R. N., op. cit., p. 97.

is a porphyritic lamprophyric greenstone which seems to be intrusive. The quartzite associated with the ore deposit is very highly metamorphosed and consists almost wholly of modified angular interlocking grains of quartz with some greenish chlorite and a little rutile and titanite.

The outcrops and the mineralized rock or ore as shown in the pits and trenches consist chiefly of a gangue of vein quartz in a brecciated mineralized and silicified granodiorite or granitic rock, in which are sporadically distributed irregular bodies of stibnite as much as 2 inches in diameter, said to carry a fair proportion of silver. Some specimens of the ore 3 or 4 inches in diameter are nearly half stibnite. The stibnite is mostly fine grained, but contains also well-striated crystals as much as an inch long. Oxidized surfaces of the outcrops and ore are in part stained yellowish with antimony oxide derived from the stibnite. The deposit probably contains considerable antimony.

The Doris K. prospect No. 3 (No. 12, fig. 6), not visited in this work, is about 3,000 feet north of the Doris K. and 300 feet higher, at an altitude of about 8,400 feet, on the opposite or Sugar Creek slope of the ridge. It trends northwest and is said to be on the first quartzite-limestone contact southwest of the one on which the Fern cinnabar deposits occur and the second southwest of the one on which the United Mercury Mines Co. cinnabar deposits occur. Quartzite forms the hanging wall, and the ore occurs mostly in the limestone, which it seems to replace. The gangue is quartz.

Development work is said to have disclosed a shoot of antimonial silver-gold ore 15 feet wide and 100 feet long. The gold and silver content is higher in the more quartzose part of the shoot. Much of the ore is reported to be relatively pure stibnite, some of it containing about 70 per cent of antimony. Several other good-looking outcrops occur farther down the slope on the contact and below it to the northeast.

MEADOW CREEK MINE

The Meadow Creek mine (No. 5, fig. 6), owned by the United Mercury Mines Co., is on Meadow Creek about three-quarters of a mile above its mouth and 100 feet above the creek, in the steep mountain side that bounds the relatively open flat-floored valley on the northwest side. The deposit was discovered about 1900 by Albert Hennessy, who in 1919 sold it to the present owners. Nearly all the development work has been done by this company since 1920. The property comprises a group of 17 claims, known as the Meadow Creek group, and the camp, consisting chiefly of two cabins and a corral.

The country rock is the granodiorite of this region. It is medium grained and fresh and is intruded by finer-grained alaskite and lamprophyric dike rocks. The deposits seem to be genetically connected with the alaskite, locally called porphyry, which is flesh-colored and slightly porphyritic and contains or is associated with stibnite and pyrite. In a part of the deep workings a dike of the lamprophyric rock 5 feet wide is said by Mr. Ross [24] to form the hanging wall. The dike contains sparsely disseminated pyrite and has been somewhat altered by mineralizing solutions, but so far as known none of it has been converted into ore.

The deposits occur in a poorly defined shear zone or lode about 500 feet wide in which the rock is more or less altered and mineralized. The lode for the most part strikes about N. 12° W. and dips steeply toward the west, but in the workings at about 600 feet in from the portal it gradually curves to the right. Where it crops out several hundred feet above and about a quarter of a mile distant from the mine the lode is much softer than the inclosing country rock and has been eroded down into a shallow gully or ravine. According to Mr. Ross, the outcrops consist chiefly of mineralized granodiorite exposed over a considerable area, with gash veins of stibnite present in places.

The lode consists mainly of crushed silicified and mineralized granodiorite, alaskite, and quartz forming the gangue, in which are variously distributed the dark sulphide ore minerals, principally antimonial silver and gold, argentite (?), tetrahedrite (?), and the antimony minerals, chiefly stibnite. Some of the alaskite has much stibnite so evenly distributed through it as to suggest that the stibnite is primary in the rock. Some of the ore seems to be almost pure stibnite. In places there occurs also some pyrite. The stibnite is mostly of submedium grain, but scattered through it are also slender bladelike crystals nearly three-quarters of an inch in length.

The deposit is opened by an adit tunnel and drift which in 1924 was about 800 feet in length and 500 feet vertically below the surface at the face. The last 400 feet was said to be mostly in good ore. During 1924, it is reported, considerable crosscutting was done.[25]

At the time of visit about 400 tons of ore derived from development work and said to average about $10 to the ton lay on the dump. In December, 1924, the company reported that it had just struck and was driving on a 5-foot ore shoot that runs $20 in gold to the ton and, by estimate, about 35 per cent of antimony.

The silver-bearing minerals other than stibnite were not determined in this work. From casual inspection tetrahedrite and argentite seem to be present. Tests made by the company are said to show that the ore contains 12 to 15 per cent of antimony. Speci-

[24] Ross, C. P., oral communication.

[25] Mining Truth, vol. 9, No. 23, p. 5, Jan. 16, 1925. The company reports that 215 feet of development work in ore was accomplished in 1925.

mens several inches in diameter collected by the writer are chiefly stibnite. In the deeper part of the workings arsenic is thought by the owners to be present in the ore, but a test made in this work of a specimen of the ore having on the joint and fracture surfaces a thin reddish coating or film, thought to be realgar, failed to indicate the presence of arsenic. The reddish film resembles cinnabar but no decisive result was obtained.

OTHER ANTIMONY DEPOSITS IN IDAHO

Antimony deposits in which stibnite is the chief ore mineral occur also in Camas, Blaine, Custer, Idaho, and Shoshone counties, Idaho, but only those in Shoshone County are known to be of commercial value. They are mostly on or near Pine Creek, near Kingston, on the main line of the Oregon-Washington Railroad & Navigation Co. The deposits occur as quartz-stibnite veins, chiefly in slate, sandstone, and quartzite of Algonkian age. Some of them are associated with porphyry dikes. Among the most productive properties are those of the Star Antimony Co., the Idaho Antimony Co., and the Coeur d'Alene Antimony Co. The last-named property has been worked intermittently since about 1898 and has produced more than 2,000 tons of ore containing more than 125 tons of metallic antimony.

It is reported that recently large deposits of antimony oxide ore have been found in Camas County, about 20 miles northwest of Hailey; that the ore averages 30 per cent of antimony and 20 ounces of silver to the ton. and that 10,000 tons has been developed.

QUICKSILVER DEPOSITS

By C. P. Ross

GENERAL FEATURES

The quicksilver deposits here described are all in an area of a little over 4 square miles in and near the valleys of Fern and Cinnabar creeks, in limestone beds forming part of the sedimentary rocks of supposed Cambrian age. The numerous small groups of claims originally located by various prospectors are now all controlled by the United Mercury Mines Co. and the Fern Quicksilver Co., principally the former. The location and extent of the two properties are approximately as shown in Figure 6. The quicksilver prospects owned by the United Mercury Mines Co. may be collectively termed the Cinnabar group. This group is the larger one outlined in Figure 6 and Plate XVIII, and the property of the Fern Quicksilver Co. is the small area entirely surrounded by it.

Most of the quicksilver ore is in limestone that has undergone igneous metamorphism and subsequent silicification, but cinnabar has also been noted in unsilicified limestone. The silicified limestone that accompanies the typical ore is composed largely of a fine-grained aggregate of quartz grains, frequently termed jasperoid, with sericite filling cracks and forming small irregular masses that apparently replace the quartz. The aplitic rocks in the T tunnel of the Hermes mine, however, were sericitized but not silicified. Pyrite grains, some of which have a tendency to crystal form, are scantily distributed and appear to have been produced later than both the quartz and the sericite. Cinnabar in small, irregular grains and in thin coatings on some of the pyrite grains was the latest mineral to form during the original mineralization. Some of it is in narrow seams in fractured jasperoid. In places such seams are so abundant as to indicate marked brecciation prior to the deposition of the cinnabar.

The silicification, sericitization, and formation of the sulphides were stages in a process of replacement of the limestone by materials introduced by infiltrating fluids. Some parts of the limestone masses are completely replaced; others are reticulated by irregular veinlets of jasperoid. Deposits so produced are characteristically irregular in shape and indefinitely bounded. In this district the quartzite was nearly impervious to the mineralizing agents, and consequently, where present, definitely limits the mineralized zone. Most of the deposits, however, are irregular, probably chimney-like masses, which grade off into comparatively unmineralized rock before the limiting barriers of quartzite are reached. Silicification seems to have been carried farther than the deposition of cinnabar, so that the presence of jasperoid is not proof that the rock has been converted into ore. On the other hand, cinnabar extends in places into unsilicified limestone, but apparently only in minor amounts and near silicified masses. The aplite dikes in the T tunnel of the Hermes mine, in contrast to the limestone, were sericitized but not silicified. The two aplitic rocks appear to have first been crushed and then had their feldspar almost completely replaced by sericite. Pyrite developed later, but is not abundant. Cinnabar is not present in the specimens collected, but a reddish stain probably resulting from its presence was noted in the finer-grained rock in places underground. The feldspar porphyry is kaolinized, not sericitized, is not known to contain any cinnabar, and consequently may have no direct connection with the mineralization.

ORIGIN

All the quicksilver deposits in the district have similar characteristics. Furthermore, the presence of stibnite in deposits of both quicksilver and gold ore and of cinnabar in antimony ore suggests that the deposits of the three metals are genetically related. Silicification of limestone and sericitization of feldspar may take place under several different sets of conditions, but in view of the association with cinnabar of the rocks thus altered it is believed that here the alteration was produced by heated solutions comparatively close to the surface. No quicksilver deposits anywhere in the world have yet been proved to be of deep-seated origin, and many have clearly been formed at shallow depths.

The heated fluids that caused the mineralization doubtless had their source in igneous rocks. Two groups of igneous rocks are present in this region. These are the Cretaceous (?) granitic rocks and associated dikes and the Miocene (?) lava flows and dikes. Deposits of lead, silver, gold, and copper ores genetically related to the Cretaceous (?) intrusions are abundant in Idaho. In the Wood River region, Blaine County, minerals containing antimony are present in the lead-silver deposits. With the exception of tetrahedrite, the antimonial minerals are among the latest formed in the deposits, and may have been introduced in a separate and later period of mineralization. Those deposits in the Wood River region in which either stibnite or cinnabar is the principal sulphide are distinct from and probably later than the lead-silver deposits related to the Cretaceous (?) granitic rocks.

Ore deposits in Tertiary rocks are widespread in Idaho, although neither as abundant or in general as large as the Mesozoic deposits. In the Thunder Mountain district, about 6 miles to the east of the cinnabar lodes of the Yellow Pine district, the gold deposits cut Tertiary volcanic strata.[26] No quicksilver deposits have been reported from the Thunder Mountain district, but the placers of the Stanley Basin district, farther south, have yielded both cinnabar and native quicksilver.[27]

Both antimony and quicksilver deposits, especially the latter, are commonly associated with volcanic rather than with plutonic intrusive rocks.[28] As noted by Mr. Schrader (p. 146), many antimony deposits are also associated with granitic rocks. Many of the quicksilver deposits in the United States are in or near Tertiary lava.[29] Some of the largest of them, however, can not be definitely dated. The antimony and quicksilver deposits of Nevada are the nearest to the Yellow Pine district that have been geologically studied. Some of these are in Tertiary lava [30] and therefore can not be older than

[26] Umpleby, J. B., and Livingston, D. C., A reconnaissance in south-central Idaho: Idaho Bur. Mines and Geology Bull. 3, pp. 3-7, 1920.

[27] Idem, pp. 15-16.

[28] Halse, Edwards, Antimony ores: Imp. Inst. Mon. Mineral Resources, with special reference to the British Empire, p. 7, 1925. Ransome, F. L., Quicksilver in 1917: U. S. Geol. Survey Mineral Resources, 1917, pt. 1, p. 386, 1919.

[29] Ransome, F. L., op. cit., pp. 386-388.

[30] Idem, p. 388.

Tertiary. Others are in Triassic or Jurassic rocks and are probably of late Mesozoic age.[31] Positive proof of pre-Tertiary age has not yet been obtained for any of these deposits, with the possible exception of those in the Rochester district.

In the Yellow Pine district the evidence is inconclusive. Both Cretaceous (?) and Tertiary dikes are present in the Hermes mine. The Cretaceous (?) aplitic rock is mineralized and consequently was intruded prior to the formation of the deposit. The Tertiary rhyolitic rock shows no evidence of mineralization either in the Hermes or in the Fern. These facts might be interpreted as evidence of pre-Tertiary age. On the other hand, such extensive brecciation as preceded the deposition of the cinnabar is more characteristic of deposits formed at shallow depths than of deeper-seated deposits. Larsen and Livingston [32] concluded that the deposition "took place at no great depth," possibly through the agency of hot springs, and "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." Whatever the mode and date of origin, it is believed that the stibnite and cinnabar deposits in this district are closely related and were formed during the same period of mineralization.

MINES AND PROSPECTS

CINNABAR GROUP

The early history of the quicksilver deposits in the Yellow Pine district, most of which are now included in the Cinnabar group, owned by the United Mercury Mines Co., has been given by Larsen and Livingston.[33] J. J. Oberbillig started his work on the Hermes group in 1918. He and his associates gradually acquired other properties, and in January, 1921, organized the United Mercury Mines Co. Since July, 1921, this company has owned all the claims in the vicinity except the Fern group. The company's property now comprises about 22 groups of claims, but none of the deposits are believed to have yielded any quicksilver except the Hermes. In 1923 its production was five flasks, and in 1924 seven flasks. A little had been produced previously. Formerly a small screw retort plant was used, but when the camp was visited in 1924 a retort plant of a new type which is calculated to treat about 35 or 40 tons of ore per day was being installed by its inventor, B. H. Smith. This plant is described on pages 163–164.

[31] Ransome, F. L., Notes on some mining districts in Humboldt County, Nev.: U. S. Geol. Survey Bull. 414, p. 71, 1909. Knopf, Adolph, Geology and ore deposits of the Rochester district, Nev.: U. S. Geol. Survey Bull. 762, p. 54, 1924.

[32] Larsen, E. S., and Livingston, D. C., Geology of the Yellow Pine cinnabar mining district, Idaho: U. S. Geol. Survey Bull. 715, pp. 79–80, 1920.

[33] Idem, p. 80.

The principal underground workings of the United Mercury Mines Co. are on the Hermes claim, near Cinnabar Camp, on Cinnabar Creek. (See Pl. XVIII and fig. 6, No. 13.) They consist of three tunnels with several branches and two raises. The lowest, the T tunnel, in 1924 had a total length of about 1,240 feet. Above this and connected with it by a vertical raise 107 feet long is the S tunnel, which with its branches has an aggregate length of 335 feet. The highest is the R tunnel, 129 feet above the T tunnel and 120 feet long. (See fig. 8.)[33a] These workings are on the southwest side of a nearly vertical limestone bed about 300 feet thick, with quartzite on both sides. Their ramifications serve to explore it for a maximum width of about

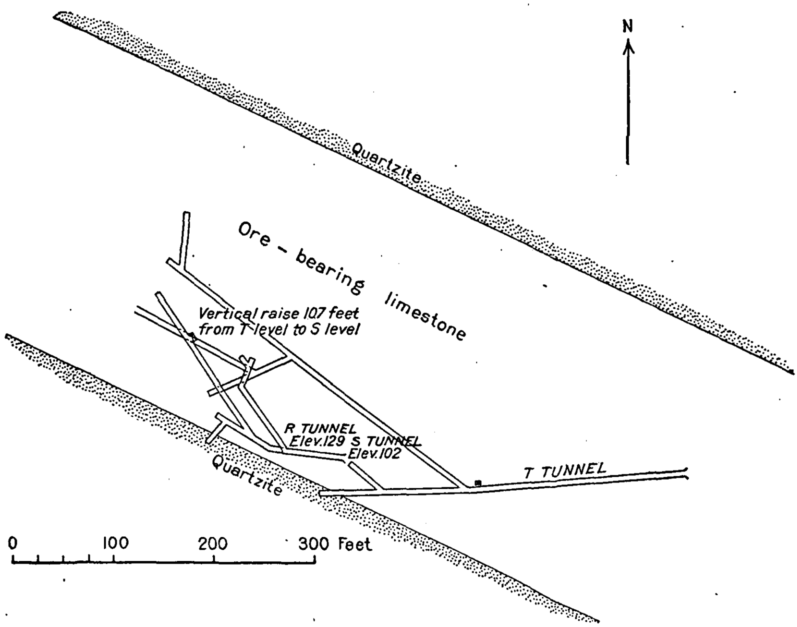

FIGURE 8.—Plan of principal workings on Hermes claim, Cinnabar group, Yellow Pine district, Idaho, owned by the United Mercury Mines Co. From map by Gordon C. Smith, October, 1923

180 feet. The quartzite penetrated by the tunnels on the southwest side of the limestone is barren. Farther northwest, on the northeast side of the limestone, are several cuts and short tunnels on the Pretty Maid and West End claims. The highest of these is probably well over 500 feet vertically above the level of the T tunnel. The workings on the three claims and the surface exposures near each serve to show that mineralization is present in places throughout the width of the limestone and for over 3,000 feet along its strike. Cinnabar stain is abundant in the workings, and crystals were noted in several places. Mr. Oberbillig, the president and manager of the company, considers as a result of his own sampling and assaying that most of

[33a] It is reported that in 1925 development work was carried 320 feet farther.

the rock exposed in the tunnels on the Hermes claim averages 0.5 per cent of quicksilver or better. Samples of material of much higher grade can be obtained in places, but in much of the rock no cinnabar is visible to the unaided eye.

In the T tunnel igneous rock of three kinds was noted. In several places a rather fine-grained white aplitic rock is exposed. Near the face of the main tunnel this kind of rock grades into a coarse-grained white rock with abundant mica. Both rocks are much altered, but the original essential minerals were quartz and feldspar. The feldspar in the specimen of the fine-grained rock examined is too much sericitized for exact determination. In the coarser rock much of that not completely sericitized is microcline. Although much of the mica in this rock is sericitic and undoubtedly a product of the alteration, muscovite was probably an original constituent. Near the exposure of the coarse-grained rock a third kind of igneous rock was found. This is too thoroughly altered for the original minerals to be determined, but in texture and general appearance it closely resembles the rhyolite porphyry that is abundant on and near the Fern property. Bell,[34] who visited the district early in its development, noted a dike of similarly altered feldspar porphyry near the face of a tunnel 100 feet long on this property, and also on the surface near by. This rock resembled that abundantly exposed at the Fern mine. The feldspar of the rock in the T tunnel is thoroughly kaolinized, and the rock at the Fern mine is similarly altered, though less completely.

The Vermilion group (No. 15, fig. 6) is in the limestone south of that containing the Hermes deposit and in the belt of metamorphosed rocks northeast of it. Cinnabar has been found here in limestone, largely altered to jasperoid, near the contact with the quartzite that borders it on the northeast. Some of the rock in the vicinity of the cuts on the Vermilion group appears to be limestone completely replaced by quartz and such minerals as biotite, scapolite, and andalusite, which are characteristic of contact metamorphism. The ore, some of which is of comparatively high grade, is largely jasperoid with disseminated cinnabar.

The White Metal group (No. 16, fig. 6) is just west of the Vermilion. Little work has been done here. Near the head of the south fork of Cinnabar Creek, on the Silver Bow group (No. 14, fig. 6), there is a prospect hole in marble which strikes N. 62° W. and dips 65° N. Several stringers of glassy quartz with stibnite crystals are exposed which in general strike nearly north and dip about 45° W. Gold, silver, and quicksilver are reported to have been found here. This prospect is not shown on Plate XVIII.

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[34] Bell, R. N., Quicksilver and antimony discoveries in central Idaho: Idaho Min. Dept. Bull. 1, p. 2, 1918.

Less than half a mile south of the Bucksbed cabin on Fern Creek is the caved tunnel of the Mountain Chief prospect (No. 19, fig 6), which is part of the Cinnabar group. As mapped on Plate XVIII this prospect is in the belt of quartzite and quartzite conglomerate which lies south of the Fern property, but the ground is covered with slide rock, so that the relations can not be seen. Hornfels float is abundant in the vicinity. Antimony, quicksilver, lead, copper, zinc, gold, and silver are reported to have been found in the ore in the Mountain Chief tunnel, but the quantity appears to have been small. Fragments of the ore collected from the dump contain cinnabar, galena, and pyrite in a quartz gangue, most of which is fine grained. The specimens are more thoroughly oxidized than the ore from other prospects and contain limonite, anglesite, chrysocolla, and other oxidized minerals of lead and copper.

On the East Fork side of the ridge, west of Cinnabar Camp, are the Midnight (No. 20, fig. 6), Hard Climb (No. 21), and other prospects belonging to the United Mercury Mines Co. They are in the most westerly belt of limestone exposed. The ore in these prospects is reported to contain stibnite and a little cinnabar. Gold and silver are also stated to have been found in some samples. Prospecting has been carried on in other parts of the Cinnabar group, but the amount of development work so far accomplished has been small.

FERN QUICKSILVER MINING CO.

The property of the Fern Quicksilver Mining Co. comprises the Fern (No. 18, fig. 6) and Bucksbed (No. 17) groups of claims, in the headwater basin of Fern Creek. Its approximate limits are indicated on Plate XVIII and Figure 6. The company was organized in 1917 by E. H. Van Meter.[35] It erected in the same year a 12-retort Johnson-McKay furnace capable of treating about 2 tons of ore a day. In 1917 five flasks of quicksilver were produced from float. In 1918 the Yellow Pine district produced 22 flasks, most of which came from the Fern mine.[36] Since then there has been little production from this mine.

The Fern group comprises most of the company's holdings. It is near the head of Fern Creek. The workings are near the southwestern boundary of the belt of marbleized limestone which lies about in the middle of the sedimentary rocks shown in Plate XVIII. The principal working is a tunnel with numerous irregular branches. Some of these expose crystalline limestone with lenses and irregular masses of siliceous material. Cinnabar occurs in such material and in the limestone near it. A large part of the tunnel is in rhyolite

[35] Larsen, E. S., and Livingston, D. C., op. cit., pp. 74–75.
[36] Ransome, F. L., Quicksilver in 1918: U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 163, 1919.

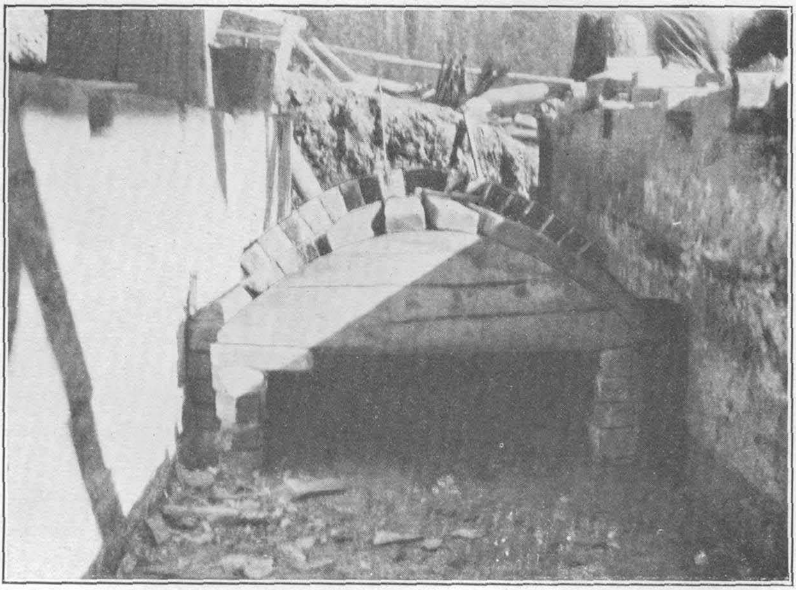
porphyry, which is softened by alteration but does not appear to have been mineralized. There are a number of cuts and short tunnels on the hillside between this tunnel and the Bucksbed workings. They are all in more or less thoroughly silicified limestone, and in several of them quicksilver ore apparently of good grade was observed. The limestone is broken by a number of slips, some of the strongest of which strike about N. 30° E. and stand nearly vertical.

The Bucksbed claim is between the Fern and White Metal groups and is in the same limestone belt. It is developed by a tunnel extending northward from the cabin on Fern Creek and big cuts on the hillside above. Work was in progress in the tunnel at the time of visit. The tunnel is in limestone, much of which is well marbleized. At and near the face the limestone is replaced irregularly by jasperoid which contains cinnabar. Some of the cuts show similar cinnabar ore and in places copper stain.

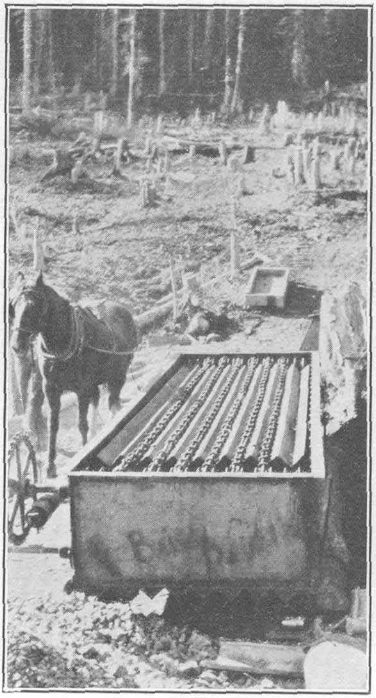
NEW REDUCTION PLANT AT HERMES MINE

The plant now being installed for retorting quicksilver at the Hermes mine is sufficiently unusual to warrant a brief description. It was invented by B. H. Smith for the treatment of oil shale. Although laboratory tests were successful, the demand for such an apparatus in the oil-shale industry did not seem likely to prove to be large in the immediate future. Tests indicated that the apparatus could be used satisfactorily on cinnabar ore, and an opportunity to try it under commercial conditions was sought. The apparatus was originally brought into the Yellow Pine district with the intention of installing it on the property of the Fern Quicksilver Co., but before this could be done new arrangements had been made, and in the summer of 1924 construction of the plant at the Cinnabar Camp of the United Mercury Mines Co. was begun. As a result of various delays the plant was not completed before snow made it necessary to halt the work. According to the annual report of the president of the United Mercury Mines Co. the plant was completed early in August, 1925, but a trial run of 800 pounds of ore resulted in disabling the plant. No further work has been done on it.

Electric power is to be generated from steam produced in a wood-fired boiler. Later a hydroelectric plant can be built if it is deemed advisable. The several units of the plant are to be operated by means of separate electric motors. The ore is to be broken by means of a jaw crusher and rolls to a maximum diameter of a quarter of an inch and then fed to the retort. This is a sheet-iron box containing four horizontal beds, one above the other. Each bed consists of a series of parallel channels of V-shaped cross section and 12 feet long. It is shown in Plate XIX, *B*. The ore in process of heating is moved slowly along the channels, dropping successively from one bed to the next beneath. It is propelled by means of chains with lugs every 6 inches, which are dragged through each channel and over pulleys at both ends of the channels. Power is furnished by a 2-horsepower motor. A charge of 1,200 pounds of ore should pass through the retort in 15 minutes, and it is hoped to treat 35 to 40 tons a day. The retort is to be heated to 800° to 850° F. by the flames from a wood-fired furnace set at one end of it. The partly completed furnace is shown in Plate XIX, *A*. The gases from the ore are to be drawn out through a manifold into the condenser by means of a 4-inch exhaust fan. The condenser is a sheet-iron box with removable cover, shown in Plate XIX, *C*. It is 12 feet long and 2 feet square in cross section. At the end toward the retort four screens are set a foot apart in the condenser box, in order to break up the incoming stream of gases and promote condensation. There are 11 removable baffles consisting of narrow sheet-iron boxes in which water is to circulate for the purpose of chilling and condensing the gases from the retorted ore. The water enters and leaves the baffles through pipes passing through the sides of the condenser box. The box, screens, and baffles are painted with Egyptian enamel to protect the iron from acids. The retort has a much larger capacity than individual retorts of any type now in use for the refining of quicksilver, and the whole plant is compact and if unsurmountable difficulties do not arise should prove efficient and economical. The condenser is constructed with more regard for completeness of recovery of quicksilver than many now in use. Few advances in the metallurgy of quicksilver have been made for many years, and this experiment will be watched with interest.

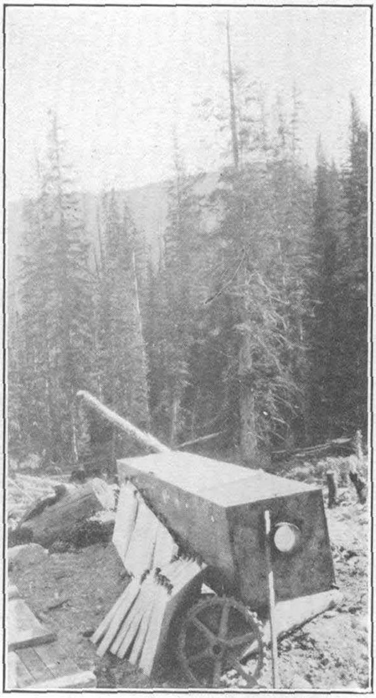


A. FURNACE FOR HEATING SMITH RETORT IN COURSE OF CONSTRUCTION AT PROPERTY OF THE UNITED MERCURY MINES CO., YELLOW PINE DISTRICT, IDAHO



B. THE SMITH RETORT

To be fitted into the space between the concrete walls in the foreground of *A*



C. THE CONDENSER FOR COLLECTING THE QUICKSILVER PRODUCED IN THE SMITH RETORT

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