A RECONNAISSANCE OF THE PINE CREEK DISTRICT, IDAHO.

By EDWARD L. JONES, Jr.

INTRODUCTION.

The Pine Creek district, Idaho, lies immediately west and south of the Wardner district of the Coeur d'Alene region. Only a small part of it was included in the area which was studied by Ransome and Calkins[1] in 1904. At that time the Pine Creek district had been only slightly developed, but under the stimulus of high metal prices recent discoveries have been made and several old prospects which formerly could not profitably market their ores were productive in 1916. The present report is based on field work by J. B. Umpleby and the writer during a three days' reconnaissance in May, 1916, and on three weeks' work by the writer in July, incident to a general study of the ore deposits of Idaho.[2]

The base for the geologic sketch map was compiled from several sources. The mapping of a strip about 1 mile wide on the eastern edge of the area is taken from the geologic map of Professional Paper 62; the topography of an area 3 miles wide on the north is adapted from the Cataldo topographic map; and the mapping of the drainage of the remaining area has been compiled from township plats. The topography of the whole area is indicated with contours drawn at 500-foot intervals. Only the general geologic relations of the northeastern part of the area are shown, no attempt being made to indicate the complicated fault structure in the workings of the Bunker Hill & Sullivan and adjacent mines.

TOPOGRAPHY.

Drainage.—The Pine Creek district lies mostly in the drainage basin of Pine Creek, which covers an area of approximately 80 square miles, comprising parts of Tps. 47 and 48 N., Rs. 1 and 2 E. Pine Creek flows north from the junction of its east and west forks to the

[1] Ransome, F. L., and Calkins, F. C., U. S. Geol. Survey Prof. Paper 62, 1908.

[2] The delay in the publication of this report has been due to the demands made on the Geological Survey for special war work. Since the field work was done the mines of the Pine Creek district have greatly increased their production of zinc-lead ore. The construction of a branch railroad line up Pine Creek was begun late in 1917.

South Fork of the Coeur d'Alene River. Denver, Stewart, and Trapper creeks are tributaries of the East Fork of Pine Creek, and Ross Fork and Langlois Gulch are tributaries of the West Fork. Government and Deadwood gulches drain the northeastern part of the area, Little Pine Creek drains the north-central part, and French Gulch drains a small basin west of Pine Creek.

Relief.—The region is mountainous, and the maximum relief is about 4,000 feet. At the eastern edge of the area an outlier of Kellogg Peak is 6,206 feet above sea level, and Pine Creek valley at the northern boundary is approximately 2,200 feet above the sea. The altitude of Wieserman Peak, in sec. 33, T. 48 N., R. 1 E., as determined by the aneroid barometer, is 5,900 feet, and the altitude of the west peak of Twin Crags, in sec. 38, T. 47 N., R. 1 E., is 6,150 feet. These peaks are on outlying spurs from the divide between the drainage systems of Coeur d'Alene and St. Joe rivers. Where Pine Creek emerges from its canyon, 2 miles from the mouth of the stream, the maximum relief of the adjacent hills is about 500 feet.

CONDITIONS AFFECTING MINING.

The Pine Creek district is favorably situated for the development of its resources. A dense forest growth of pine, fir, cedar, and tamarack, much of it suitable for use in mining, covers a large part of the Pine Creek basin. Water is abundant for milling, but the stream flow is insufficient for the development of power. Power can readily be purchased, however, from the Washington Water Power Co., which has branch lines to the Hypotheek, Highland-Surprise, and Constitution mines.

The shipping point of mines on Pine Creek at the time when the field work was done was Pine Creek station, on the Coeur d'Alene branch of the Oregon-Washington Railroad & Navigation Co.'s line, which follows the valley of Coeur d'Alene River. In 1917 railroad surveys were made from Pine Creek station up Pine Creek to the Highland-Surprise mine, on Stewart Creek, and to the Constitution mine, on the East Fork of Pine Creek. Each mine is about 9 miles distant by wagon road from the station, and the Northern Light, Little Pittsburg, Nabob, and Douglas mines are from 4 to 8½ miles from the station. The construction of the Pine Creek branch was begun in the fall of 1917, but after several miles of grade had been built the work was suspended in 1918. It is expected, however, that the work will be resumed in the near future, and the completion of the railroad to the mines will greatly increase the production of the district. Ore is hauled from the Hypotheek mine down French Gulch to Kingston, 4 miles to the north, another station on the Oregon-Washington Railroad & Navigation Co.'s line. The district

LIST OF MINES AND PROSPECTS

ZINC-LEAD VEINS

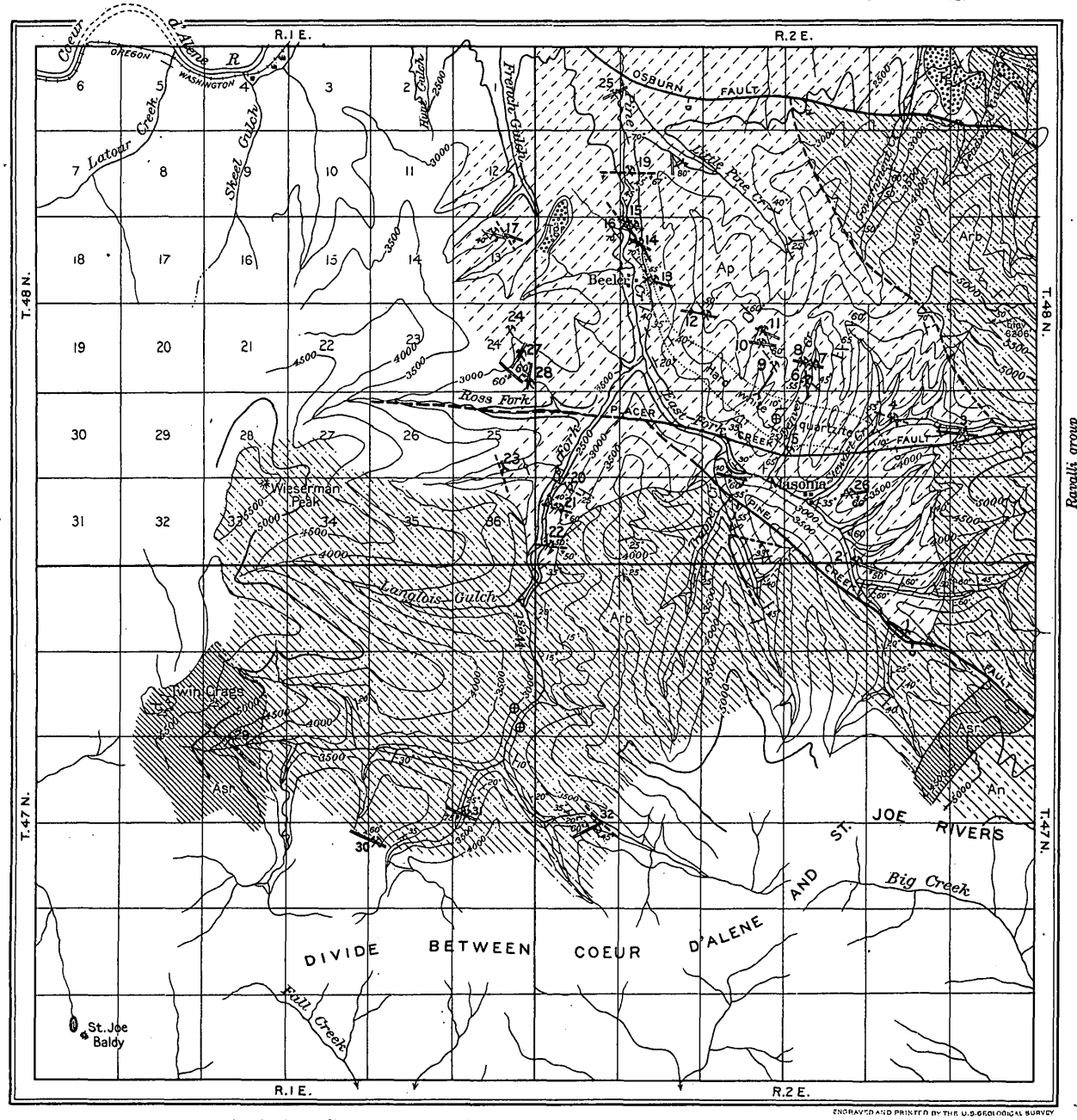
1. Constitution
2. Douglas
3. Highland-Surprise
4. Nevada Stewart
5. Hilarity
6. Little Pittsburg
7. Sydney
8. Denver
9. Nabob
10. V
11. Idaho
12. Liberal King
13. Carbonate
14. Amy Matchless
15. Bobby Anderson
16. Northern Light
17. Hypotheek
18. Big Eight
19. Corby
20. Spokane
21. International
22. Sherman
23. K. C.
24. Tiberius

ANTIMONY VEINS

25. Coeur d'Alene Antimony
26. Star Antimony
27. Pearson
28. Hannibal

SIDERITE VEINS

29. Palisade
30. Black Diamond
31. Equitable
32. Colusa



EXPLANATION

SEDIMENTARY ROCKS

TERTIARY

Tgr — Bench gravels *(Mapped only in part)*

ALGONKIAN (Belt series)

Ar — Newland ("Wallace") formation *(Mainly calcareous shale, greenish and bluish gray, with abundant impure siliceous and magnesian limestones and calcareous quartzites in middle part, all in thin beds. Thickness 4,000± feet)*

Asr — St. Regis formation *(Purple and green shale and quartzitic sandstones) Thickness 1,000± feet)*

Arb — Revett and Burke formations *(Thin-bedded gray fine-grained sericitic quartzite grading into massive white quartzite above. Total thickness 3,200± feet)*

Ravalli group

Ap — Prichard formation *(Mostly gray-blue banded slate in lower part, massive white quartzite beds with slate in middle part, and gray-blue banded slate and thin-bedded gray quartzite in upper part. Thickness 8,000+ feet)*

SYMBOLS

Fault
D, *Downthrow*

Probable fault

Strike and dip

Strike and dip of vein

Horizontal bed

Strike of vertical strata

Mine or prospect

Tunnel

GEOLOGIC SKETCH MAP OF THE PINE CREEK DISTRICT, IDAHO

Scale 1/125,000

1 ½ 0 1 2 3 Miles

Contour interval 500 feet

Datum is mean sea level

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is served with mail by a stage running daily from Kellogg to the small settlement of Beeler and to Masonia, a post office recently established at the junction of Stewart Creek and the East Fork of Pine Creek.

HISTORY AND PRODUCTION.

Many claims were located in the Pine Creek district soon after the discovery of ore in the Coeur d'Alene district, but little work was done on most of them until recently, when high metal prices stimulated their development and resulted in a considerable production of the complex zinc-lead and antimony ores. Of the older mines the Hypotheek has been worked at intervals for 29 years, and the Coeur d'Alene Antimony mine is reported to have been first worked in 1885, but little is known concerning the early history of most of the older properties. The Highland-Surprise group of claims was located about 1900, and the Douglas group in 1898. The Constitution and Star Antimony lodes are recent discoveries, the latter having been located in 1914.

Active shipping began about 1914 from the Highland-Surprise and more recently from the Constitution, Star Antimony, Pearson, and Douglas mines. With the opening of a new ore body and the operation of a new mill in June, 1916, the Hypotheek mine became an active and profitable producer. Much work is being done in the district in building concentration mills and experimenting on processes of ore extraction.

The Highland-Surprise and Hypotheek mills were in operation in 1916, and a 100-ton mill at the Constitution mine was completed and put into operation in 1917. According to reports in the mining press the construction of mills at the Northern Light and Nabob mines was also begun in 1917. The Anaconda Copper Co., which is operating the Douglas mine under bond, is treating the ore in an electrolytic smelter at Great Falls, Mont.

The total production of the district is not known, but ore to the value of several hundred thousand dollars was shipped during 1916. Of this amount the Hypotheek mine produced $90,000.

GEOLOGY.

The Pine Creek drainage basin is underlain chiefly by sedimentary rocks of Algonkian age, termed the Belt series. These rocks are intruded by small black dikes, mainly along faults. Deposits of well-rounded gravel of Tertiary age cap many of the low hills adjacent to Coeur d'Alene River, but these deposits are only partly represented on the accompanying map (Pl. I).

SEDIMENTARY ROCKS.

BELT SERIES.

SUBDIVISIONS.

The sedimentary rocks exposed in the Pine Creek district belong to the Belt series and range from the Prichard formation at the base to the Newland ("Wallace") formation at the top. The Striped Peak formation, which overlies the Newland in the Coeur d'Alene section, to the east, is not present in the Pine Creek district within the area of this reconnaissance.

The Belt series has a great development over northwestern Montana and northern Idaho. The terms under which the formations in the Coeur d'Alene district are described are not used in the designation of the Belt rocks farther east. The "Wallace" formation has been correlated with the Newland formation (the term "Newland" is more generally used), and the Burke, Revett, and St. Regis formations constitute the Ravalli group. These formations are described in Professional Paper 62 as follows:

Wallace: Shales, more or less calcareous, interbedded with thin layers of siliceous and ferruginous limestone and calareous sandstones. Limestones and calcareous shales weather buff. 4,000 feet.

St. Regis: Shales and sandstones, purple and green. 1,000 feet.

Revett: White quartzite, partly sericitic. 1,200 feet.

Burke: Indurated siliceous shales, with sandstones and quartzites, prevailingly posed. 8,000+ feet.

Prichard: Argillite, blue-gray to black, with distinct and regular banding, interbedded with a subordinate amount of gray sandstone. Uppermost part arenaceous and marked with shallow-water features. Base not exposed. 8,000+ feet.

In the course of a detailed study of the geology and ore deposits of the Wardner district Oscar H. Hershey,[1] geologist for the Bunker Hill & Sullivan Co., has made further subdivisions of the Prichard, Burke, and Revett formations. Only the subdivisions of the Prichard will be considered here, as this formation is economically the most important in the Pine Creek district.

Hershey has divided the Prichard formation into upper, middle, and lower members. The upper and lower members, consisting mainly of banded blue-gray to black slates, have many characteristics in common and are difficult to distinguish without a general knowledge of the section, but the middle member is characterized by thick beds of white and gray quartzite. Near Kellogg the middle

[1] Hershey, O. H., Genesis of lead-silver ores in Wardner district, Idaho: Min. and Sci. Press, vol. 104, pp. 750, 753, 786–790, 825–827, June 1, 8, and 15, 1912; Origin and distribution of ore in the Coeur d'Alene, published for the author as a pamphlet by the Min. and Sci. Press, 32 pp., 1916.

member attains a maximum thickness of 75 feet, but in the Pine Creek district the maximum thickness is probably not less than 350 feet.

DISTRIBUTION AND STRUCTURE OF FORMATIONS.

The Prichard formation occupies the central part of the Pine Creek basin, where it forms in general an anticlinal fold modified by faulting. This structure is shown by the outcrop of the quartzite beds of the middle member of the Prichard. These beds are best exposed and are thickest between Denver Creek and the Placer Creek fault, which cuts them off on the south. Here, owing to local folding, they occupy a belt half a mile wide, but from this locality northwestward to the Northern Light mine the belt gradually narrows, owing largely to steepening of the dip to the east. The lithology also changes, and in place of a massive quartzite bed 350 feet thick at Stewart Creek, near the Placer Creek fault, the formation at the Northern Light mine is represented by two quartzite beds 50 and 75 feet thick, separated by banded blue slates and alternating quartzitic layers. From the Northern Light mine the quartzite belt extends westward to the Hypotheek mine, but it is too thin to be represented on the map and it can not be traced continuously because of the surface mantle and deposits of old bench gravels that cover the low ridges between these mines. The crest of the anticline is in the vicinity of the Hypotheek mine, for variable dips of the quartzite bed are shown in the mine workings. In the western part of the mine the beds dip dominantly to the west; in the eastern part they dip to the east or northeast; and flat beds lie between. The maximum thickness of Prichard rocks exposed in the Pine Creek basin is in the area east of Pine Creek between the Placer Creek and Osburn faults. The beds in this area probably range in stratigraphic position from a horizon a few hundred feet below the middle member of the Prichard to a horizon near the top of the formation. They dip at variable though in most places steep angles to the east. Estimates were made along several traverses, and it is believed that not less than 6,000 feet of beds are exposed, but faults that have no surface expression may modify these estimates.

The Burke and Revett rocks of the Ravalli group flank the Prichard formation on the east and south and in part on the west. To the east, between the Osburn and Placer Creek faults, the line of separation between the Prichard and Ravalli rocks is probably another fault, for although there is no pronounced topographic expression of a fault, the slates are abruptly succeeded by quartzite beds of discordant dip. Between the Placer Creek and Pine Creek faults the

slates are overlain conformably by the younger quartzites. Here the beds strike in general north and dip to the east.

To the south the Burke and Revett rocks overlie the Prichard formation normally west of a point near the forks of Trapper Creek, but east of Trapper Creek these formations are brought into contact by the Pine Creek fault. On the West Fork of Pine Creek excellently exposed slates and overlying quartzites dip at moderate angles, generally to the east or southeast, though in places the beds are flat. West of the Sherman prospect, on the West Fork of Pine Creek, the slates are overlain by massive quartzites that extend to the summit of Wieserman Peak. Purple and green shales and quartzite of the St. Regis formation conformably overlie the Revett and quartzite in the southwestern part of the area, in the vicinity of Twin Crags. The Newland formation is mapped over a small area between branches of the East Fork of Pine Creek, and it probably occupies a large area on the divide between Coeur d'Alene and St. Joe rivers.

FAULTS.

Extensive faulting has occurred in the Pine Creek district, particularly in the area of Prichard rocks and on its borders. The Osburn, Placer Creek, and Pine Creek faults, of large displacement and pronounced topographic expression, shown on the geologic map accompanying Professional Paper 62, have been traced into the Pine Creek basin. All these faults are of the normal type, with the downthrow on the south or southwest.

Osburn fault.—The Osburn fault, which strikes a little north of west, traverses the low-lying country in the northern part of the area. It cuts off the belt of Burke and Revett rocks which lies north of the Placer Creek fault, but for the most part it traverses the Prichard formation. The importance of the Osburn fault has recently been emphasized by O. H. Hershey,[1] who has assembled evidence indicating that there was a maximum horizontal displacement to the west on the south side of the fault of 12 to 15 miles in the Coeur d'Alene district, probably after the formation of the ore deposits.

If this supposition of a postmineral horizontal displacement of several miles is correct, the ore deposits of the Wardner and Pine Creek districts originally occupied positions adjacent to the deposits of the Ninemile and Canyon Creek basins. Studies in the Pine Creek district give strong supporting evidence of great horizontal displacement on the Osburn fault. This evidence will not be treated in detail in this paper, but it may be said briefly that the dome structure of the Prichard in the Pine Creek district, with the structure in the same

[1] Hershey, O. H., Origin and distribution of ore in the Coeur d'Alene, pp. 4–5, published for the author as a pamphlet by the Min. and Sci. Press, 1916.

rocks flanking it on the east, is similar to the structure in the same formations on the north side of the Osburn fault between Osburn and Ninemile Creek.

The ore deposits also in the Prichard formation in each of these areas have many features in common.

Placer Creek fault.—The Placer Creek fault is another fault of great persistence, which has been traced eastward for 35 miles through the Coeur d'Alene district to the summit of the Bitterroot Mountains, on the Idaho-Montana line. It extends across T. 48 N., R. 2 E., from the south side of Stewart Creek in sec. 25 to Ross Fork in sec. 30 and probably continues westward along this stream for some distance. The displacement along the Placer Creek fault is probably not great in the Pine Creek district. Near the eastern part of T. 48 N., R. 2 E., it displaces the quartzites of the Ravalli group and cuts off sharply the hard white quartzite bed in the middle of the Prichard formation, but for most of its course in the township it traverses the Prichard slates, which give little clue to its displacement.

Pine Creek fault.—The Pine Creek fault strikes northwest and has been traced from the east boundary of T. 48 N., R. 2 E., in sec. 12 to a point near the Placer Creek fault in sec. 29. The faults of the northwesterly system, of which the Pine Creek fault is a member, are older than the Osburn and Placer Creek faults, which cut off some of them.

The Pine Creek fault has probably been displaced by the Placer Creek fault, and its continuation may be a fault that has been observed in the Northern Light and Amy-Matchless mines, although no fault can be traced continuously in the greatly disturbed and contorted slates that lie below the quartzite beds of the Prichard between the Placer Creek fault and the Northern Light mine.

Other faults.—Many other faults occur in the Pine Creek basin, particularly in the Prichard formation, but they have no pronounced topographic expression and were noted chiefly in mine workings. Along some of these faults ore deposition has occurred, but other faults cut the ore bodies. In general they trend northwesterly, but some trend east of north and others nearly due east.

A fault that is apparently of considerable magnitude marks the boundary, at least in part, between the Prichard slates and the Burke and Revett quartzites in the area between the Placer Creek and Osburn faults. This fault can not be readily traced on the surface, but on either side of it near the head of Government Gulch discordant strikes and dips were noted, and there is an abrupt change from slate to quartzite. This fault may be the one designated by O. H. Hershey the Government Gulch fault.

North of the Placer Creek fault a belt of sheared dike rocks extends along a small stream tributary to Ross Fork. The shearing of the dike rocks is attributed to faulting.

In the Hypotheek mine a fault displaces the vein, and in the K. C., Spokane, International, and Sherman prospects other faults were noted.

In the area of Burke, Revett, and St. Regis rocks in the southern part of the district the structure is undisturbed by faulting except for the slight fissures subsequently filled by the siderite veins.

IGNEOUS ROCKS.

DISTRIBUTION.

Igneous rocks are not abundant in the Pine Creek district, though they are widely distributed. They occur as narrow basic dikes, commonly in or adjacent to the larger faults, but some have no relation to faulting. Granite or monzonite dikes have not been found in the district. Fine-grained dark-colored dike rocks were noted in the Highland Surprise mine along the Placer Creek fault, in the Constitution mine near the Pine Creek fault, and in the Amy-Matchless mine and Corby prospect adjacent to well-defined faults. Along the belt of siderite veins in the southern part of the Pine Creek basin the rocks of the Ravalli group are cut by dikes that are not related to major faults, though they are similar to those found in the Prichard formation in fault zones.

PETROGRAPHIC FEATURES.

All the dike rocks are classed under the general term lamprophyre, though when examined in thin sections they show considerable variation in texture and mineral composition, and some are given more specific names.

Several dikes from 1 to 20 feet wide were cut in a tunnel on the Palisade group of claims. They trend from north to N. 30° W. and cut purple and green shales and quartzite of the St. Regis formation which strike northeast and dip southeast. The following brief petrographic descriptions are largely taken from notes by E. S. Larsen, who examined several of the dike rocks in thin section:

One rock of porphyritic texture and gray color from the Palisade group is too much decomposed for accurate identification. A little partly bleached biotite, some apatite, and considerable partly decomposed plagioclase are the only original minerals that can be recognized. There is much secondary carbonate, sericite, quartz, and chlorite. This rock is poorer in dark minerals than normal lamprophyres.

Another dark olive-gray dike rock carries prominent biotite flakes. It is made up of nearly equal amounts of olivine, pale-brown biotite, and albite. Apatite is abundant in small rods, and iron ore is present. The biotite and olivine are in crystals as much as 2 millimeters across; the albite is in coarse, much-elongated crystals, collected together in sheathlike aggregates. The olivine is altered to a strongly birefracting fibrous or platy chloritic mineral similar to that described below as occurring in the camptonites. This rock is classed as an olivine-albite kersantite.

A rock from the same locality, classed as olivine camptonite, is a very fine grained dark olive-gray rock that shows in the hand specimen abundant minute prisms of hornblende. It is made up of about equal amounts of labradorite, brown hornblende, augite, altered olivine, and groundmass; there is some iron ore and apatite. The crystals are about 0.5 millimeter in greatest dimension. The olivine is completely replaced by carbonates, a fibrous serpentine with a birefringence of about 0.01, chalcedonic quartz, and a chloritic mineral with strong birefringence. The augite is partly altered to a fibrous chlorite or serpentine. The groundmass is very finely crystalline and when fresh may have been partly glass.

A dike rock in the Constitution mine is similar to the olivine camptonite from the Palisade tunnel, but it contains more olivine and much less hornblende. The olivine is largely altered to a platy, strongly birefracting chloritic mineral, and there is much secondary quartz and carbonate in the section.

AGE OF DIKE ROCKS.

In the Coeur d'Alene district most of the basic dike rocks were intruded after the period of ore deposition. The relation of dikes to ore is not clearly shown in the Pine Creek district, though in both the Highland-Surprise and Constitution mines the dikes occur in the ore-bearing fissures. The dikes are apparently nowhere replaced by ore, though in the Highland-Surprise mine the dike partly incloses the ore. This relation is thought to be due, however, to recurrent movements along the fault planes. In this mine also the ore body has been displaced by faults, whereas the dike is undisturbed.

ORE DEPOSITS.

GENERAL FEATURES.

The ore deposits of the Pine Creek district are metasomatic fissure veins and fissure fillings, with gradations between the two types. The veins that show metasomatic replacement are best developed in shear zones along major faults; the fissure fillings are best developed along

minor faults or in zones of moderate shearing. The deposits occur principally in the area of Prichard rocks, where the faulting and distortion of the strata have been most severe. The veins are chiefly valuable for their zinc, lead, silver, and antimony content, though some contain also gold and copper. These veins are probably best classified on the basis of their dominant metal or mineral content, into zinc-lead, antimony, and siderite veins. The veins that contain antimony and siderite, and possibly the Hypotheek vein, are of a distinct mineralogic character; the zinc-lead veins are closely related in mineralogy and origin.

ZINC-LEAD VEINS.

CHARACTER.

The best examples of the metasomatic fissure veins are those of the zinc-lead type. The most valuable ore is a fine-grained aggregate of sphalerite and galena in which there are commonly fragments of unreplaced wall rocks. Pyrrhotite accompanies the ore and in places is the chief mineral. Chalcopyrite is usually present in small amounts. Gangue minerals are sparingly developed, and of these quartz is the most abundant, accompanied rarely by siderite and calcite. The Highland-Surprise, Constitution, and Douglas mines are on veins that clearly show replacement on or adjacent to large faults.

In the mineral belt which extends northwestward from the Highland-Surprise mine to the Northern Light mine the veins have in general a west-northwest strike and the fissures which they occupy are thought to be due to the same dynamic forces. As the distance from the Placer Creek fault is increased the metasomatic type of vein gradually gives way to the fissure type, and the change is accompanied by changes in mineral composition. In the veins covered by the Nabob, Little Pittsburg, Denver, and Sydney claims, about 2 miles northwest of the Highland-Surprise, the ore is coarser grained and the quartz gangue more abundant than in the Highland-Surprise mine, though siderite is likewise rare. The ore minerals of these veins consist chiefly of sphalerite and galena, but pyrrhotite is locally abundant and chalcopyrite occurs in greater amount than in the Highland-Surprise vein. In the Idaho and V veins, which are opened by prospects a short distance northwest of the Nabob mine, and the Liberal King and Carbonate veins, still farther northwest, on the slope toward Pine Creek, the deposits are fissure fillings with fairly well defined walls. Quartz is abundant in the gangue, but siderite is only locally prominent. Sphalerite, galena, chalcopyrite, and pyrite, generally coarse grained, are the ore minerals of these veins, but pyrrhotite was not observed. Chalcopyrite is

particularly abundant in the Liberal King vein, where it probably occurs in sufficient quantity to constitute an ore of copper. The chalcopyrite contains small amounts of gold. A specimen from the Carbonate mine which showed abundant galena and chalcopyrite was assayed for gold and silver, and gave results of 5.6 ounces of silver and 0.08 ounce of gold to the ton. An assay of a partly oxidized specimen from the Liberal King vein composed principally of pyrite with a little chalcopyrite gave 0.67 ounce of silver and 0.03 ounce of gold to the ton. In the Northern Light mine there are several parallel veins contained in two massive white quartzite beds and in blue siliceous slates and quartzites about 200 feet thick which lie between the massive quartzites. A northwesterly fault with strongly developed gouge occurs on the southwest side of the veins, but had not been penetrated by the mine workings at the time of visit. Near this fault a large vein was intersected in November, 1916, which is reported to be of the replacement type and to contain abundant galena, sphalerite, and pyrrhotite. The other veins, which lie north of the large one, are narrow veins of the fissure type, though some lie in or on the walls of shear zones. In these veins the dominant minerals are galena and pyrite in a quartz gangue with subordinate siderite. Sphalerite occurs sparsely, but pyrrhotite was not observed.

The Hypotheek vein, which is from 2 to 15 feet wide, is of the fissure type and cuts hard, massive quartzite and associated blue and gray siliceous slates of the middle of the Prichard formation. Galena, chalcopyrite, pyrite, and tetrahedrite are prominent in this vein, which contains also a little arsenopyrite. The gangue minerals are quartz, calcite, and siderite, which in general predominate over the sulphide minerals of the vein. Noteworthy features of the primary mineralization in the Hypotheek vein are the occurrence of tetrahedrite, the abundance of calcite in the gangue, and the absence of pyrrhotite and sphalerite.

COMPARISON WITH DEPOSITS OF COEUR D'ALENE DISTRICT.

The zinc-lead deposits of the Pine Creek district, though but a few miles from the great deposits of the Wardner district, are notably different from those deposits in mineralogy, although in both areas the deposits have several characteristics in common. The Pine Creek deposits are contained solely in the Prichard formation, whereas the Wardner deposits occur in the quartzites of the Burke and Revett formations. The deposits of both areas are metasomatic fissure veins that occur adjacent to areas of intense faulting, but in the Wardner deposits galena is the dominant sulphide, sphalerite occurs only in small amounts, and pyrrhotite is practically absent. The gangue is abundant siderite and quartz.

The zinc-lead deposits of the Pine Creek district have more in common with those that occur in Prichard rocks in the Ninemile district than with the veins of the Wardner type. The veins of the Interstate-Callahan mine are the best-known examples of metasomatic veins in Prichard slate. The dominant mineral of these veins is sphalerite, but galena occurs also and in the upper parts of the vein was the chief mineral of the ore. Pyrrhotite occurs in small amounts, generally at the ends of the ore shoots. Siderite is nowhere abundant.

The difference in the mineral composition of the ore deposits in the Prichard formation in the Pine Creek and Ninemile districts and those in the Burke and Revett formations in the Wardner district are believed to be due largely to differences in the intensity of the forces by which the deposits were formed and in smaller part to the influence of the wall rocks on the deposition of the ores. The deposits in the Prichard rocks were formed under greater heat and pressure than those in the Wardner district, as shown by the abundance of sphalerite in the Interstate-Callahan veins and of sphalerite and pyrrhotite in the veins of the Pine Creek district and by the scarcity of siderite in the veins of the Ninemile Creek and Pine Creek areas. The occurrence of the lead-ore shoots in the upper parts of the Interstate-Callahan veins also suggests the conclusion that the galena was generally deposited at higher horizons than sphalerite.

That the character of the wall rocks may influence mineral deposition is shown by several veins of the Pine Creek district that cut both the slate and quartzite. Where quartzite forms the walls galena is much more abundant in the vein than where it is inclosed by slate.

ANTIMONY VEINS.

The antimony veins of the Pine Creek district, though few in number, are widely distributed in the area of Prichard slates. They are not confined to one system of fractures, for all have widely divergent strikes and dips. These veins occupy fault fissures in which lenses and irregular bodies of quartz commonly occur. They differ markedly from the other veins of the district in mineral composition. The principal metallic sulphide is stibnite, which has been formed by a replacement of either the slate wall rocks or the quartz gangue. Pyrite is a common constituent of these veins, and here and there they contain sphalerite.

SIDERITE VEINS.

Manganiferous siderite veins occur in the southern part of the Pine Creek basin. These veins are simple fissure fillings that are found in a west-northwesterly zone between the Colusa and Palisade

prospects. The country rocks of these veins are the Burke, Revett, and St. Regis formations. No important ore bodies have yet been developed in any of them, though chalcopyrite occurs sparsely in some.

DEPTH OF OXIDATION.

The present ground-water level is nowhere far below the surface, and in most of the metalliferous veins of the Pine Creek district the oxidized zone is shallow. Commonly the sulphides are found at or within a few feet of the surface. The Hypotheek vein is an exception, and indeed this deposit is unique in the Coeur d'Alene region in that the oxidized ores in places extend 1,100 feet below the collar of the shaft, or approximately 700 feet below the level of Coeur d'Alene River. To account for this great depth of oxidation three factors must be considered—the permeability of the vein, probable change of the ground-water level, and possible downfaulting after oxidation. It is notable that the greatest depth of oxidation is in that part of the vein west of a northwesterly fault along which the commercial bodies of lead ore occur. Outside this lead ore shoot on the 700, 900, and 1,100 foot levels the ore is entirely unoxidized, and here probably the sulphides continued nearly to the surface, but this could not be verified, because the 700-foot level is the first opening below the collar of the shaft.

The part of the vein that contains the lead ore shoot has been extensively fractured subsequent to the deposition of the galena. This fracturing permitted the easy circulation of meteoric water, but the persistence of the oxidized ores far below the ground-water level can not be attributed to mere permeability of the vein, but must be the result of some physiographic change which affected the ground-water level. Physiographic evidence outside the area discussed in this report shows that Coeur d'Alene River was in pre-Miocene time several hundred feet below its present level, and the ground-water level of the area adjacent to it was correspondingly lower. During Miocene time great lava flows dammed the stream, and later, during Pliocene time, large accumulations of glacial débris filled the channel; since then neither the stream nor the ground-water level has ever regained its former position. With regard to faulting there is no supporting evidence that the shoot of oxidized ore on the hanging wall of the fault had been displaced 1,000 feet or more and thus preserved from erosion. The vein itself is displaced only 50 feet, and the massive quartzite beds on either side of the fault plane show little evidence of great disturbance.

The large siderite veins in the southern part of the Pine Creek basin are oxidized at the surface, but on account of their meager development the depth of alteration has not been determined.

MINERALOGY OF VEINS.

The primary sulphide minerals of the Pine Creek district are galena, sphalerite, pyrite, pyrrhotite, chalcopyrite, tetrahedrite, stibnite, and arsenopyrite. The minerals that resulted from the oxidation of the sulphides are cerusite, malachite, massicot, pyromorphite, and chalcocite. Of the sulphide minerals sphalerite, galena, pyrite, pyrrhotite, and chalcopyrite have the widest distribution and occur in nearly all the veins of the zinc-lead type. Tetrahedrite, the gray copper sulphide, is abundant in the Hypotheek mine but was observed in only one other vein in the district. Stibnite (antimony sulphide) was observed only in the veins that are being worked for antimony. Arsenopyrite was noted sparingly in the Hypotheek vein and may occur in some others. Cerusite, the carbonate of lead, is abundant in the Hypotheek mine and occurs in the surface ores of the Northern Light mine and Carbonate prospects. Massicot, the yellow oxide of lead, occurs in the Hypotheek mine. Pyromorphite, a phosphate of lead, is present in the Hypotheek and Northern Light veins. Malachite, the copper carbonate, and chalcocite, the copper sulphide, are secondary minerals of the oxidized zone developed after chalcopyrite and tetrahedrite. These minerals were noted in the Hypotheek mine and in the superficial ores of several prospects that lie between the Highland-Surprise and Northern Light mines.

PERSISTENCE OF VEINS.

The veins of the Pine Creek district have not been sufficiently developed to prove their extent in depth, but in length and thickness several of the zinc-lead veins compare favorably with those of the Coeur d'Alene district. The most persistent vein zone is that which extends between the Highland-Surprise and Northern Light mines, a distance of 5 miles. None of the numerous veins that crop out in this zone have been traced continuously between these points, and it is thought probable that the zone comprises veins of moderate length only, more or less in alinement with one another, and that they pinch out in the slates and are succeeded a short distance beyond by other veins. In some of the mines continuous ore shoots from 600 to 800 feet long have been developed; in others the ore is in shoots of moderate length separated by barren vein matter. The deepest workings are those of the Hypotheek mine, 1,100 feet below the collar of the shaft. As the altitude of the collar is approximately 2,700 feet, the lowest ore in the district is 1,600 feet above sea level. The Northern Light mine has a 400-foot shaft, but the other zinc-lead producers gain depths of a few hundred feet, principally through long tunnels.

MINES AND PROSPECTS.

In the subjoined description the mines and prospects are divided into three groups—those on zinc-lead veins or veins of allied origin; those on antimony veins; and those on veins in which the dominant vein matter is siderite and in which sulphides are sparse. All the mines and prospects are numbered on the accompanying map, and the corresponding numbers are given in the descriptive text.

MINES AND PROSPECTS ON ZINC-LEAD DEPOSITS.

The zinc-lead deposits occur almost wholly in the Prichard formation. The mines and prospects are described in geographic order from the Constitution mine, in the southeastern part, northward to the Hypotheek mines, and thence southward to the prospects on the West Fork of Pine Creek.

CONSTITUTION.

The Constitution group of 10 claims (No. 1 on Pl. I), 8 of which are patented, lies on the East Fork of Pine Creek in sec. 2, T. 47 N., R. 2 E. The date of location was not learned, but the principal development work is very recent, and production began in March, 1916. The shipment of ore is greatly hampered by lack of transportation facilities. At the time of visit about 12 tons a day of hand-sorted ore was being hauled to Pine Creek station, 9 miles north of the mine. During the fall of 1916 construction work was commenced on a 100-ton concentration mill, the lumber for which was obtained from a sawmill on the property. The mill was expected to be put into operation January 1, 1917. Electric power is obtained from the Washington Water Power Co. through a branch transmission line which supplies also the Highland-Surprise mine. A 5-drill compressor and small hoist is operated by a 100-horsepower motor. The developments consist of a tunnel driven from the creek level for 850 feet and an inclined shaft of 200 feet with drifts on the 100 and 200 foot levels.

The tunnel intersects the vein 60 feet from the portal and follows it to the face with a course of S. 45° E. The vein occupies a zone of shearing in Prichard slates closely parallel to the Pine Creek fault. In several places along the vein the Burke and Revett rocks on the hanging-wall side of the fault are exposed, and locally the quartzites have been replaced by ore. The vein generally pitches steeply south, but in places along the drift a north dip was observed. The inclined shaft sunk on the vein is at an angle of 76° S. A dike 2 to 4 feet wide, of dark fine-grained rock, previously described as olivine camptonite, occurs in the vein fissure in the outer 100 feet of the tunnel and on the 100 and 200 foot levels.

In the tunnel section the ore occurs in two shoots separated by 100 feet or barren or low-grade vein matter. The outer shoot, first encountered 60 feet from the tunnel portal, is 400 feet long and from 2 inches to 5 feet wide. The inner shoot extends 265 feet back from the face of the tunnel, and its average width is 4½ feet. Ore has been mined from this shoot in stopes that extend 25 feet above the tunnel level. From the shaft on the 100-foot level drifts 55 feet southeast and 35 feet northwest show a little ore. A drift 200 feet long on the 200-foot level, after passing through low-grade ore distributed as stringers in the slate, at the face cut ore of good grade about 3 feet wide.

The ore was formed by the replacement dominantly of slate and in smaller part of quartzite. It is very fine grained and consists of an intimate mixture of sphalerite and galena grains, with a little pyrrhotite and pyrite. Small seams of galena occur sparsely in the fine-grained ore. Quartz is the dominant gangue mineral of the vein but is nowhere abundant in the ore. Near the face of the tunnel there is much quartz with a little calcite and siderite, but the ore here pinches out.

The hand-sorted ore contains a higher silver ratio than the ores from other mines in the Pine Creek district. The average of the assays of wagon-load lots prior to May 1, 1916, gave 27.7 per cent of zinc, 10.1 per cent of lead, and 9 ounces of silver to the ton.

A thin section of lean ore shows clearly that the metallic sulphides replace the country rock. The specimen examined is a fine-grained impure quartzite, the grains of which are partly replaced by sphalerite and galena. Sphalerite greatly predominates. The two sulphides are intergrown and were deposited contemporaneously. A few grains of calcite and sericite were noted in the section.

DOUGLAS.

The Douglas mine (No. 2) is on the East Fork of Pine Creek 1 mile north of the Constitution mine. Seven full claims and two fractions, all patented, make up the group. The ore body is said to have been discovered in 1898 or 1899, but the mine made no production until the fall of 1916, when it was acquired under bond by the Anaconda Copper Co. The ore is treated at the company's electrolytic zinc smelter at Great Falls, Mont. The developments consist of three tunnels, a winze, and a raise. No. 3 tunnel, at the east bank of Pine Creek, is driven on the vein 930 feet; No. 2 tunnel, 130 feet above No. 3, has 460 feet of development; and No. 1 tunnel, 150 feet above No. 2, has about 160 feet but is now caved. A winze 150 feet deep has been sunk near the portal of tunnel No. 3, and at the time of visit a raise was being driven to connect with tunnel No. 2.

The vein trends N. 70° W. and dips about 45° SW. In tunnel No. 3 it is from 4 inches to 7 feet wide, and its average width is 4 feet, including 20 inches of first-class ore. The vein is contained in a shear zone in blue and black Prichard slates. It has been considerably deformed since its deposition, as is shown by irregularities in its course and by variability in its thickness. The walls of the vein, however, are fairly well defined. The ore is extremely fine grained, like the slate which it replaces. It consists of an intimate mixture of sphalerite and galena with minor amounts of iron sulphides. Small fragments of unreplaced wall rock are commonly observed in the ore. Quartz is the dominant gangue mineral, but it is nowhere abundant, and siderite was not observed. The ore is said to average 20 per cent of zinc, 4 to 8 per cent of lead, 3 to 6 ounces silver to the ton, and about 6 per cent of iron.

HIGHLAND-SURPRISE.

The Highland-Suprise mine (No. 3) is near the head of Stewart Creek, at an altitude of 3,250 feet. The group consists of 18 claims, all of which are surveyed for patent. It was located about 1900, but serious exploitation did not begin until 1911, when after the property had changed hands several times the present company began operations. A 150-ton mill was built, and since October, 1915, the mine has been actively productive, though the output is hampered because of poor transportation facilities. The Highland-Surprise was in 1916 the largest producer of zinc-lead ore in the Pine Creek district. The mine is developed by two main tunnels, known as the lower Highland and lower Surprise tunnels, 117 feet vertically apart, and two short upper tunnels that are now in disuse. At the time of visit (July, 1916) a shaft was being sunk on the vein from the level of the lower Surprise tunnel. From this tunnel a haulage track leads to the mill, about 1,000 feet from its portal. The total length of the mine workings is about 5,000 feet. Stopes have been opened on the vein at different points, the largest stope in the west end of the mine, where from the lower level for a distance of 140 feet the ore has been taken out to the surface, 225 feet above, on a 70° dip.

The vein trends a few degrees north of west and is nearly parallel to the Placer Creek fault, which it closely follows in the east end of the mine. Toward the west, however, the vein is offset by several faults, each of which displaces it from 30 to 150 feet, away from the Placer Creek fault; in the lower Highland tunnel the vein is 350 feet from the Placer Creek fault, and in the lower Surprise tunnel it is still farther away, though the distance was not determined, as the Placer Creek fault was not cut on this level. The thin-bedded shales and slates of the Prichard formation cut by the Highland-

Surprise workings trend in general parallel to the Placer Creek fault, and similarly have steep dips to the south.

The vein is mainly a product of the replacement of the slates along a zone of fissuring that diverges from the Placer Creek fault at a small angle. The walls of the vein are in general poorly defined, but the vein is usually mined for a width of one set of timbers. The ore minerals are sphalerite, galena, pyrrhotite, pyrite, and rare chalcopyrite. The association of minerals and texture of the ore varies from place to place along the vein. From the main ore shoot at the west end of the mine the mill feed assays from 12 to 20 per cent of zinc, 3 to 7 per cent of lead, 1½ ounces of silver to the ton, and from 5 to 7 per cent of iron. About 200 feet farther east the vein consists principally of pyrrhotite and pyrite. A partial analysis of the vein at this point, by the Northport Smelting & Refining Co., gave no gold, 0.4 ounce of silver to the ton, no lead, no copper, 0.6 per cent of zinc, 3.7 per cent of silica, 54.6 per cent of iron, and 24.7 per cent of sulphur. Still farther east sphalerite and galena appear with the iron sulphides, until with increasing abundance of the lead and zinc minerals and decrease of the iron the ore becomes of good grade. Most of the ore is fairly coarse grained and is amenable to concentration and separation of the zinc and lead, but the ore in one shoot near the east end of the mine, which contains about 30 per cent zinc with some lead and iron minerals, was too fine grained and complex to be treated successfully by the mill equipment in use at the time of visit, though it will probably yield to flotation after being finely ground. The gangue consists principally of quartz, but this mineral is abundant only in the leaner parts of the ore shoot. Siderite is notably absent from the ore, though in places thin films of calcite were noted. Unreplaced fragments of slate are common in the ore. Some of the ore is a fine-grained mixture of sphalerite and galena that were apparently deposited at the same time; in other parts of the vein fine-grained sphalerite is cut by veinlets of galena. The relation of pyrrhotite to other minerals of the vein is not apparent from the specimens collected in this mine.

The footwall of the Placer Creek fault is followed by a dark-colored dike which is 40 feet wide where cut by the lower Highland tunnel. In the easternmost end of the mine on the lower Surprise level the dike is much narrower and the ore occurs on the footwall side of it. The dike is thought to be younger than the ore, for the vein has been displaced by a fault, whereas the dike is undisturbed. Locally ore extends into the dike, but this is thought to be due to crushing movements.

The ore is concentrated in a mill whose daily rated capacity is 150 tons, but at the time of visit from 80 to 100 tons a day was being treated. The equipment consisted of rolls, jigs, Wilfley tables, and

Callow flotation tanks. During the fall of 1916 a large tube mill and several flotation cells were added to this equipment and increased the mill capacity to 175 tons a day. The present extraction is about 64 per cent of the assay value of the ore, but with finer grinding in the tube mill the extraction will probably be increased and a better product obtained. The zinc concentrates assay from 37 to 41 per cent of zinc, 6 per cent of lead, 3 ounces of silver to the ton, and 5 to 7 per cent of iron; the lead concentrates, 55 per cent of lead, 19 ounces of silver to the ton, and 7 to 8 per cent of iron. From October, 1915, to June, 1916, about 1,500 tons of zinc concentrates and 275 tons of lead concentrates had been shipped.

NEVADA–STEWART.

The Nevada-Stewart (No. 4) is on the north side of Stewart Creek, about half a mile west of the Highland-Surprise mine. The principal opening is a tunnel at the creek level driven N. 20° E. for 800 feet. An upper tunnel that is probably not over 200 feet above the lower one has a small amount of development work but it was not visited. At the face of the lower tunnel thinly banded Prichard slates strike N. 20° E. and dip 30° W., but in the outer part of the tunnel the formation is much contorted. At 500 feet from the portal the drift intersects a fault which trends N. 65° W. and dips steeply south. This fault is probably the same fracture as that in which the Highland-Surprise vein occurs, as both are in alinement and have practically the same course. The fault is explored by a drift driven 275 feet east. The fault zone is about 5 feet wide between well-defined slickensided walls. It is said to have contained some galena and sphalerite, though only pyrite was observed in the face of the drift. The company had suspended operations a short time before the writer's visit.

HILARITY.

The Hilarity prospect (No. 5) is on Denver Creek a mile from its mouth. The group comprises seven unpatented claims. Two tunnels on opposite sides of Denver Creek explore a vein which trends N. 30° W. In the north tunnel about 500 feet of work has been done, and in the south tunnel 150 feet. The vein occurs along a slip in bluish and gray shales of the Prichard formation which dip 80° SW. In the south drift the ore ranges from 6 inches to 2 feet in width; in the north tunnel it is disseminated in scattered small lenses. The ore is of low grade and consists of an intimate mixture of pyrite, sphalerite, pyrrhotite, and a little galena and chalcopyrite. Quartz is the dominant gangue mineral, though nowhere abundant, and calcite was noted in places as small stalactites.

LITTLE PITTSBURG.

The Little Pittsburg mine (No. 6) is on Denver Creek about 1½ miles above its junction with the East Fork of Pine Creek. Two unpatented claims constitute the group, which is owned by G. A. Smith and Mrs. Hall, of Kellogg, Idaho. During the winter of 1915 a 150-ton mill was built and the property bonded, but the company became involved in litigation and little work was done. Preparations were being made at the time of visit to reopen the mine.

The mine is developed by two tunnels, 125 feet vertically apart. The upper tunnel, at an altitude of 3,150 feet, is a crosscut 500 feet long to the vein in which is a drift of 200 feet. The vein strikes N. 15° W., dips 65° SW., and cuts beds of blue slates that strike N. 45° W. and dip 65° SW. The ore ranges from 4 to 21 feet in width and has fairly well defined walls. In the upper tunnel the vein is cut by a fault which strikes N. 42° W. and dips 60° SW., and the ore is displaced 12 feet to the east. Very little ore has been taken out; at one place a stope is 25 feet above the tunnel.

The ore is a fine-grained mixture of sphalerite, galena, pyrite, pyrrhotite, and chalcopyrite with quartz and unreplaced wall-rock gangue. Reported assays from samples of the mine are as follows: From a 21-foot face, 8 to 10 per cent of zinc and 5 per cent of lead; from another part of the vein, 16 per cent of zinc, 12 per cent of lead, and 22 per cent of iron. The reported assay of a sample of concentrates gave 60 per cent of lead and 24 ounces of silver to the ton. The amount of development work is too small to determine the extent of the ore body, for the vein has been explored only in the upper tunnel by the drift and a 25-foot raise.

The lower tunnel is about 1,000 feet south of the upper tunnel and 125 feet lower at the creek level. It is driven northward for 150 feet. The country rock at the portal is a massive white quartzite with disseminated siderite, grading toward the face, with alternating grayish quartzite and slaty bands, into slate. At the face a northwestward-trending fault with a heavy gouge dips 45° SW. and has slate on both walls.

SYDNEY.

The Sydney group (No. 7) consists of 19 unpatented claims north of the Little Pittsburg mine. The group is developed principally by a tunnel starting at the level of Denver Creek at an altitude of 3,300 feet and driven N. 28° E. 500 feet to its intersection with the vein. Drifts on the vein extend 150 feet to the east and 75 feet west. At 80 feet beyond its intersection with the vein the tunnel cuts a vertical fault with gouge 3 feet wide, which strikes N. 80° W. The vein strikes about N. 78° W. and is nearly vertical. The wall rocks are

the bluish slates of the upper Prichard. Stringers and masses of pyrrhotite, pyrite, sphalerite, and a little galena are distributed in a zone from 1 to 8 feet wide. In places the sphalerite is quite free from iron, but as a whole the ore is of low grade and probably does not contain more than 6 per cent of zinc across any part of the zone. The vein in the Sydney workings is exposed on the Denver claim, to the west; the face of the west drift in the Sydney tunnel is not far from the end line of the Denver claim.

DENVER.

The Denver claim (No. 8) was located over a vein that crops out in the bed of Denver Creek. A tunnel driven west 50 feet is on this vein, and 25 feet to the south another tunnel 70 feet long explores a parallel vein. The northern vein shows in the creek bed from 2 to 3 feet of high-grade sphalerite and galena ore. The vein trends N. 65° W. and apparently is vertical. The Nabob Mining Co., which has extensively developed the country northwest of the Denver claim, has undertaken the exploitation of the Denver claim, which it procured through an option. This work was begun in July, 1916, with a force of 8 men, and it is reported that the extension of the northerly tunnel on the discovery vein disclosed an ore shoot 140 long and from 2 to 4 feet wide. Assays of the ore are said to run 31 per cent of lead, 20 per cent of zinc, and 19 ounces of silver to the ton. It is proposed to explore this ore shoot further through the west Sydney drift, where a depth of 100 feet below the Denver working will be obtained. The south vein on the Denver claim is from 1 to 2 feet wide and is composed principally of pyrrhotite and quartz. The wall rocks are sheared slates.

NABOB.

The Nabob mine (No. 9) is in the SE. ¼ sec. 21, T. 48 N., R. 2 E. Two patented claims are included in the group. The developments are extensive, probably over 4,000 feet of work having been done, but at the time of visit operations were suspended and the long drift and crosscut west of the shaft were inaccessible on account of bad air. The principal work has been directed through a lower tunnel driven on a course N. 43° W. for about 2,200 feet, to a station at the intersection with the Nabob fissure. From the portal the tunnel penetrates hard white quartzite of the middle part of the Prichard formation for 500 feet and then passes into the conformably overlying slates and intercalated layers of quartzite. In the tunnel section the formation strikes northwest and dips 40°–60° NE. The wall rocks of the Nabob vein strike N. 20° W. and dip 80° E.; the vein strikes N. 75° W. and dips 55° S. The Nabob vein on the

tunnel level is developed by a drift to the west of 600 feet. From this point a long crosscut to the north is reported to have cut the V and Idaho veins, whose outcrops were noted on the surface, but this crosscut was not accessible at the time of visit. From the station a raise extends to the surface, 420 feet on the dip of the vein, and a winze was sunk 100 feet below the tunnel level. About 600 feet back from the station a vein known as the Crystalite is developed by a drift to the east for several hundred feet. The Nabob vein has been opened near its outcrop by two tunnels aggregating several hundred feet in length. Several carloads of ore is reported to have been shipped from these workings; the last shipment of two cars was made in February, 1916. The vein here strikes N. 80° W. and dips 60° S., and the slate and quartzite wall rocks strike N. 50° W. and dip 50° NE.

The ore of the Nabob fissure in the upper workings is a mixture of galena, sphalerite, pyrrhotite, and pyrite in a gangue consisting dominantly of quartz. Pyrrhotite becomes much more abundant in the vein in the lower levels. At the station the vein, whose maximum width is 3 feet, is composed principally of fine-grained pyrrhotite in which there are a few narrow seams of galena and small amounts of sphalerite and chalcopyrite. The Crystalite vein strikes N. 75° W. Its maximum width is about 8 inches, but the ore is of higher grade than that of the Nabob fissure and consists of fine-grained galena and sphalerite. Ore on the dump, said to have been obtained from the V vein, shows galena, sphalerite, pyrite, and chalcopyrite in a quartz and siderite gangue.

V AND IDAHO.

The adjoining V (No. 10) and Idaho (No. 11) claims are located on veins 350 feet apart as exposed in the bottom of a gulch that drains southward past the portal of the Nabob tunnel. These veins are explored by old workings in the gulch bottom.

The V vein is prospected by a shallow shaft and a short tunnel driven to the east. The vein strikes N. 80° W. and apparently is vertical. The Idaho vein is developed by a drift 200 feet long from a short crosscut tunnel. It strikes N. 60° W. and is vertical. Each vein is about 2 feet wide.

The veins are essentially fissure fillings, though in places fragments of the sheared slate wall rocks are included in them and are partly replaced by ore. The ore differs from that of the Nabob vein in the abundance of chalcopyrite and quartz gangue and in the absence of pyrrhotite. Sphalerite, galena, and pyrite occur less abundantly than chalcopyrite. The ore is partly oxidized in these workings,

as shown by malachite stains and thin films of sooty chalcocite on chalcopyrite. The minerals are intimately associated and give little clue to their order of deposition.

LIBERAL KING.

The Liberal King property (No. 12) lies near the northeast corner of sec. 20, T. 48 N., R. 2 E., on a steep hillside sloping to Pine Creek. Two tunnels several hundred feet apart have been driven here, but the principal developments are in the upper tunnel, which is at an altitude of 3,550 feet, is driven eastward 500 feet, and intersects the vein a short distance from the portal and then follows the north wall to the face. Several crosscuts were driven across the vein at intervals of about 100 feet. The vein trends N. 75° W. and is mostly vertical, but in some places it dips steeply north and in others steeply south. The vein is a fissure filling 7 feet wide with generally well-defined walls, but in places numerous quartz veinlets lead into the slate wall rocks. Near the portal of the upper tunnel the vein is stained with copper carbonates and there is considerable chalcocite. The ore minerals are pyrite, sphalerite, chalcopyrite, and galena in a quartz gangue. In places the quartz for a width of several feet is almost free from sulphides. Siderite was not observed in the vein. The copper, zinc, and lead content of the vein was not determined, but an assay for gold and silver gave 0.67 ounce of silver and 0.03 ounce of gold to the ton. Chalcopyrite is the most abundant ore mineral of the vein, closely followed by sphalerite. Galena occurs as thin films in the fine-grained sphalerite and is evidently the later of the two, but the order of deposition of the other minerals of the vein is not apparent in the specimens collected.

CARBONATE.

The Carbonate prospect (No. 13) is on the east side of Pine Creek opposite Beeler. The principal developments are in the upper tunnel, 150 feet above the stream. About 1,000 feet of work has been done, mainly along a fracture that trends N. 70° W. and dips steeply south. The country rocks are thick-bedded grayish quartzites and interbedded blue shales and slates of the middle part of the Prichard formation. Considerable distortion of the strata is shown in crosscuts north and south from the main fissure. In the south crosscut the beds strike N. 20° W. and dip 50° E.; at the face of the drift the beds strike N. 50° E. and dip 60° NW.; a short distance north of the portal the dominant trend of the formation is northwest and the dip 55° NE.

The vein is a narrow fissure, in places containing a wall-rock breccia cemented by quartz and carbonates. Near the portal the

vein is stained with green copper salts; toward the face chalcopyrite, pyrite, galena, and a little chalcocite were noted. Galena appears to be more abundant where the fissure cuts quartzite beds. A specimen of the ore was assayed for gold and silver by Ledoux & Co. and gave a content of 5.6 ounces of silver and 0.08 ounce of gold to the ton. A lower tunnel, 125 feet above Pine Creek, comprises several hundred feet of development work, but no ore has been found in it.

AMY-MATCHLESS.

The Amy-Matchless group (No. 14), consisting of 10 claims and 2 mill sites, lies on both sides of Pine Creek about half a mile north of Beeler. No work was being done here at the time of visit, and the workings were inaccessible on account of bad air.

The Amy tunnel is driven from the east side of Pine Creek to a distance, as reported, of 4,000 feet. The vein is said to trend northwest and dip southwest and to lie on the contact between quartzite and slate. A dark-colored dike from 9 to 24 feet wide follows the fissure. This dike was not microscopically examined, but it has the appearance of lamprophyre. Ore on the dump consists of rather coarse grained galena and sphalerite in a gangue of quartz and siderite with a little calcite. The length and width of the ore shoot were not learned. The ore is reported to have been displaced about 500 feet by a fault. On the Matchless claim, on the west side of Pine Creek, there is an inclined shaft whose collar is 150 feet above the creek level. The developments are slight, and there is but little ore on the dump. Thinly laminated gray and blue quartzites and slates of the Prichard formation are well exposed. They strike N. 40° W. and dip 70° NE.

BOBBIE ANDERSON.

The Bobbie Anderson prospect (No. 15) is an old discovery that lies on the east side of Pine Creek. A carload of galena ore was shipped from it many years ago. A shaft near the creek level is reported to be 180 feet deep, but it is now partly filled with water. A tunnel 30 feet below the collar of the shaft explores the vein for 100 feet to the east. The vein is about 1 foot wide in the tunnel but is reported to be 6 feet wide in the bottom of the shaft. It is contained in banded blue slates and quartzites of the Prichard formation. The ore is principally chalcopyrite, pyrite, and galena in a quartz gangue with sparse siderite. A specimen from this prospect shows an interesting relation between chalcopyrite, sphalerite, and galena. The chalcopyrite is in two bands at opposite ends of the specimen. It is very fine grained and greatly sheared, being traversed near its

borders by veinlets of galena and a little sphalerite. Sphalerite as medium-grained nodules an inch or more in diameter occurs between the bands of chalcopyrite but is mostly inclosed by galena of coarser texture which shows no evidence of shearing. From these relations in this specimen it is believed that the chalcopyrite was deposited first and sphalerite and galena later. In another specimen, however, galena and chalcopyrite appear to be contemporaneous with vein quartz, a relation which indicates recurrent deposition of the minerals in the vein.

NORTHERN LIGHT.

The Northern Light group (No. 16) comprises five unpatented claims on the west side of Pine Creek about three-quarters of a mile north of Beeler. The discovery was made in 1894, but the active exploitation of the property dates from June, 1915, when it was acquired by the present company. Up to July, 1916, about 1,800 feet of development work had been done in a surface tunnel of 370 feet, a 400-foot shaft, and drifts on the 100, 200, and 400 foot levels. The country rocks of the veins consist of two beds of hard, massive quartzite separated by slates with intercalated gray and blue thin-bedded quartzite. One quartzite bed, 50 feet thick, crops out above the shaft; the other bed, 100 feet thick, crops out 200 feet south of the shaft. The formation strikes in general northwest and dips at a high angle to the northeast, but in places on the lower levels the beds are vertical.

Four veins have been cut by the workings. These veins trend about west-northwest and dip south at angles varying between 45° and 60°. Veins Nos. 1, 2, and 3 are narrow fissures from a few inches to 2 feet wide distributed in a zone of more or less intense shearing about 250 feet wide. No large ore shoot has been encountered in any of these veins; in some ore occurs for about 100 feet along the strike with a maximum width of 2 feet. Vein No. 2 crops out in the massive quartzite bed above the shaft, but below the surface it passes into the underlying slates and thin-bedded quartzite. About 6 inches of galena or its oxidation products, cerusite and pyromorphite, was exposed in a surface cut on this vein.

The ore of veins Nos. 1, 2, and 3 is composed principally of medium-grained galena with pyrite and small amounts of sphalerite and chalcopyrite in a quartz and siderite gangue. A valuable ore body was encountered in vein No. 4 in the fall of 1916, according to Mr. B. G. Harmon, manager of the mine. This vein, which has a conspicuous outcrop of barren quartz, had not been cut in the mine workings until a crosscut was driven south on the 400-foot level. The sheared quartzite country rock, near vein No. 4, contains abun-

dant pyrrhotite and pyrite. The ore is composed largely of sphalerite and galena, though in places pyrrhotite is abundant. Chalcopyrite occurs in small amounts. Several specimens from vein No. 4 were mailed to the writer by Mr. Harmon. In some of them galena, sphalerite, and pyrrhotite are intimately associated and are contemporaneous, but in others small seams of galena cut the pyrrhotite. The deposit was formed largely by replacement of the sheared quartzite. Where cut by the crosscut the vein was estimated to be 9 feet wide. It dips about 45° S. The ore shoot has been developed for 200 feet along its strike; at the east end the ore is cut off by a northwesterly fault, but at the west end the vein maintains its width with 2 feet of solid shipping ore and the remainder of mill grade. Assays of the solid ore gave 27 per cent of lead, 30 per cent of zinc, and 8 ounces of silver to the ton. The milling ore assays from 3 to 8 per cent of lead, 6 to 10 per cent of zinc, and 1.5 to 3 ounces of silver to the ton.

HYPOTHEEK.

The Hypotheek Mining & Milling Co. acquired sec. 13, T. 48 N., R. 1 E., by purchase from the Northern Pacific Railway Co., and the mine (No. 17) is in the NE. ¼ of the section, near the head of French Gulch. A wagon road through French Gulch connects the property with Kingston, 3 miles to the north. The mine is one of the old properties of the district and has been worked intermittently since 1887, but no information as to its production prior to 1916 was available. During the period from June, 1916, when the mill began to operate, to December 20, 1916, the Hypotheek mine produced 1,173,860 pounds of lead, 7,096.64 ounces of silver, and 122.68 ounces of gold, the total value of which was about $90,000. This output was made from an ore shoot recently discovered in the vein west of a fault which displaced it about 75 feet to the south on the hanging-wall side. The old workings, now abandoned, are on the west side of French Gulch, east of the fault. They consist of an adit tunnel in which, 600 feet from the portal, a vertical shaft of 700 feet was sunk with drifts of several hundred feet on the 500 and 700 foot levels. Connection is made from the 700-foot level of the old workings with the 700-foot level of the new workings. An old concentrator stands in French Gulch, 400 feet from the portal of the tunnel.

The new workings are at the head of a gulch, tributary to French Gulch, 1,500 feet west of the portal of the old tunnel. This work was begun in 1913 and consisted in the sinking of an 1,100-foot shaft with drifts aggregating about 2,500 feet on the 700, 900, and 1,100 foot levels. A barometric reading at the collar of the shaft gave an altitude of 2,700 feet. The hoist house, compressor building, and mill

are closely grouped about the collar of the shaft. Electric power is obtained from the Washington Water Power Co.'s line.

The country rocks of the vein are gray and blue slates and thin-bedded quartzites, with a bed of massive white or gray quartzite 50 feet or more thick, which crops out in French Gulch at several places in such a manner as to indicate dome structure. These rocks are regarded as the middle member of the Prichard. In the underground workings the strata show variable dips. In places the slates dip north or at an acute angle to the strike of the vein, but in the crosscut on the 1,100-foot level they lie flat for a distance but gradually dip south and approach the dip of the vein. In the west drift on the 1,100-foot level the formation dips southwest. Massive grayish quartzites are in some places on the hanging wall and in other places on the footwall of the vein.

The vein strikes N. 70° W. and dips about 70° S. A fault that strikes N. 40° W. and dips steeply to the southwest offsets the vein about 50 feet to the south on the hanging-wall side. This fault marks the division of the mine into the old and new workings. The vein differs markedly on the two sides of the fault both in the mineralogy of the vein and in the depth of oxidation. East of the fault the vein was examined on the 700-foot level only, where connection is made between the old and new workings. Here the vein has an average width of several feet. In some places it is a network of veinlets in slate; in others it is a solid vein composed of quartz and carbonates. Calcite is abundant in places. The sulphides have a sporadic and small development in the vein. There is one small stope on this level, and small bunches of ore are said to have been stoped above the 700-foot level, but that part of the mine was not examined. The ore at the stope on the 700-foot level is composed of chalcopyrite, tetrahedrite, pyrite, and arsenopyrite in a gangue of quartz, calcite, and siderite. No galena was observed here, although it is said to have been stoped from small bunches above the 700-foot level. The vein is not oxidized east of the fault on this level. West of the fault the vein is explored for 600 feet to the shaft.

The ore shoot is about 400 feet long and 5 feet wide. No stoping has been done on this level, because the connection with the new shaft was made from the old workings, and the slope is therefore toward the east away from the shaft. The ore is completely oxidized and consists of porous iron and manganese oxides in which are crusts of quartz and cerusite crystals. Practically all the ore being mined at the time of visit was obtained from the 900-foot level and from an intermediate level 60 feet below the 900-foot level. On the 900-foot level the ore shoot is 400 feet long and from 2 to 15 feet wide, with an average width of 6 feet. The vein, or that part of it

which constitutes the lead ore shoot, is oxidized to a remarkable extent. Much of it is a light and porous mass of iron and manganese oxides in which is a network of thin crusts of quartz and finely divided cerusite. Against the footwall are generally masses of pure galena, many of them 1 foot or more in diameter, coated with beautiful cerusite crystals. In breaking open apparently solid masses of galena little nests of carbonate crystals were found. Massicot, malachite, and pyromorphite also occur in the oxidized ore. West of the point where the crosscut intersects the vein the fissure is occupied by lenses and irregular masses of quartz sporadically mineralized with galena, pyrite, and sparse chalcopyrite and tetrahedrite. The vein west of the crosscut is narrow and is not oxidized.

On the 1,100-foot level the crosscut from the shaft to the main vein is 200 feet long. A smaller vein was cut about 75 feet from the shaft, and drifts have been run on it to the east and west for 500 feet. The small vein is parallel to the larger one in strike but dips 50° S. It is from 8 inches to 2 feet wide. West from the crosscut ore occurs probably in commercial quantity for a distance of 100 feet. It consists of bunches of galena, pyrite, chalcopyrite, and tetrahedrite in a gangue of quartz, calcite, and siderite. Seams of well-crystallized tetrahedrite occur in the ore near the west end of the drift. The tetrahedrite is clearly younger than the vein quartz, but nowhere was its relation to chalcopyrite or galena clearly shown. In the main vein on the 1,100-foot level, east of the crosscut, the ore occurs in shoots separated by barren vein matter. Some of the shoots are 75 feet long. The oxidized parts of the vein are coextensive with the shoots of lead ore. At the west end of the drift chalcopyrite, galena, and tetrahedrite occur in the quartz and carbonate gangue, but the distribution of these minerals is too scattered for profitable mining. In the east end of the drift calcite is very abundant in the vein.

The ore shoot on the 900-foot level contains about 9 per cent of lead. Shipments of crude ore contain an average of 75.4 per cent of lead, with 8.38 ounces of silver and 0.018 ounce of gold to the ton. About 3 or 4 tons of crude ore is sorted by hand each day.

The concentrates consist principally of cerusite, galena, and some tetrahedrite and chalcopyrite. Smelter returns of the concentrates gave an average of 50.65 per cent of lead, with 6.23 ounces of silver and 0.125 ounce of gold to the ton. The crude ore and concentrates are smelted in the smelter at Northport, Wash., where the ore is desired because of its predominant carbonate.

The mill has a rated daily capacity of 180 tons, but at the time of visit between 70 and 80 tons a day was being treated. The equipment consists of jigs, tables, and vanners, which make a saving of 70 per cent of the lead content of the ore.

The Hypotheek vein is unique among the veins of the Pine Creek district in the association of the sulphide and gangue minerals. The abundance of galena in some parts of the vein and the association of chalcopyrite, tetrahedrite, arsenopyrite, and galena in other parts are noteworthy features. Sphalerite and pyrrhotite, which are common in many of the veins of the district, were not observed in the Hypotheek ores. Tetrahedrite, which generally carries a high silver content in ores of the Coeur d'Alene district, is barren of this metal in the Hypotheek mine. A partial analysis of the mineral by R. C. Wells, of the Geological Survey, gave 36.5 per cent of copper, no silver, and about 21 per cent of antimony. The silver of the ores is therefore probably contained in galena, and the gold is probably contained in chalcopyrite.

BIG EIGHT.

The Big Eight tunnel (No. 18) is in the NE. ¼ sec. 8, T. 48 N., R. 2 E., on the west side of Little Pine Creek. The workings aggregate about 2,100 feet and consist mainly of a tunnel whose course is S. 50° W., with short drifts on two small veins intersected by the tunnel. Thinly banded gray, blue, and black shales and quartzites of the Prichard formation are the rocks of the tunnel section. The formation strikes from north to N. 30° W. and dips 55°–80° E. A vein intersected by the tunnel 500 feet from the portal is about 1 foot wide. It lies in the bedding and trends N. 30° W. and dips 75° NE. At 1,400 feet from the portal another vein was cut, and drifts were run on it for 200 feet. It strikes N. 10° E. and dips 80° E. The vein matter is quartz, which ranges from a few inches to 1 foot in width. Coarse grains of tetrahedrite and a light-yellow sphalerite occur sparingly and are apparently contemporaneous with the vein quartz.

CORBY.

The Corby prospect (No. 19) is developed by a tunnel 500 feet long driven eastward on the east side of Pine Creek. The tunnel follows a fault in greatly crushed black slates of the Prichard formation. The fault strikes east and dips 67° S. at the face of the tunnel, where there is a tough black gouge 6 inches wide. A dark dike about 20 feet wide occurs in the hanging wall of the fault.

SPOKANE.

The Spokane group (No. 20), consisting of three unpatented claims, lies on the east side of the West Fork of Pine Creek in sec. 21, T. 48 N., R. 2 E. The claims were located in 1912. They are developed by a tunnel 500 feet long driven southeastward from the

valley level. The country rocks are greatly sheared and contorted blue siliceous slates of the Prichard formation. They contain many quartz veinlets, which generally lie in the bedding. The largest vein has a maximum width of 2 feet as exposed in a crosscut south from the main tunnel. It strikes N. 50° W. and dips 45° SW. It lies along a fault plane on which there is black gouge several inches thick. Galena, sphalerite, and pyrite are sparingly disseminated in the veins or occur in small bunches. They are associated with abundant white glassy quartz and some coarse siderite and calcite.

INTERNATIONAL.

The International group (No. 21) consists of nine unpatented claims south of the Spokane group. The principal opening is a tunnel 500 feet long driven from the creek level along a fissure that trends S. 80° E. and dips 60° S. Bunches and irregular veinlets of quartz and associated minerals make out in places along this fissure. Galena, sphalerite, pyrrhotite, and pyrite occur with the quartz and subordinate siderite gangue, though the development work has nowhere disclosed any considerable ore body. Blue slates and interbedded quartzite layers show great variation in strike and dip in the tunnel section. A dark-colored dike that is rich in biotite extends for a short distance along a slip parallel to the main fissure.

SHERMAN.

The Sherman group (No. 22) is developed by a tunnel 750 feet long driven from the east bank of the West Fork of Pine Creek. At the portal of the tunnel blue slates and interbedded gray quartzites strike N. 20° E. and dip 55° E., but toward the end of the tunnel they strike N. 60° E. and dip 30° S. The tunnel is driven eastward along a fissure which is conformable for the most part to the bedding planes of the slates. A quartz vein with a maximum width of 1 foot occurs in the fissure. Here and there slips, transverse to the main fissure, displace the vein. Galena, sphalerite, chalcopyrite, and abundant pyrrhotite and pyrite are the ore minerals of the vein. The gangue is dominantly a glassy white quartz, but in places calcite and siderite are abundant.

K. C.

The K. C. prospect (No. 23) is in sec. 25, T. 48 N., R. 1 E., on the north side of Bear Gulch about three-quarters of a mile west of its junction with the West Fork of Pine Creek. Here a tunnel is driven N. 75° W. for 100 feet in greatly sheared slates to a vein in a fault

fissure which trends N. 25° W. and dips about 80° NE. A drift on the vein extends about 250 feet to the north, with short crosscuts into the footwall. The fault marks the contact between blue slates on the east and a gray quartzite to the west, both rocks probably in the upper part of the Prichard formation.

The vein is from 1 to 2 feet wide, and the ore is an intimate mixture of sphalerite, galena, pyrite, chalcopyrite, and a little pyrrhotite. Quartz, siderite, and calcite are the gangue minerals.

TIBERIUS.

The Tiberius prospect (No. 24) is in sec. 24, T. 48 N., R. 1 E., at the head of a small gulch tributary to Ross Fork. It is developed by a tunnel, probably not over 200 feet long, driven to the west. This tunnel was not accessible at the time of visit. The rock on the dump is a greenish sericitic schist or slate. It has the appearance of a greatly sheared dike rock, but there is little clue to its origin even when it is examined in thin section. The rock is composed of sericite, quartz, and chlorite with some calcite grains. About 2 tons of zinc ore is on the dump. The vein is apparently about 1 foot wide and is composed of sphalerite and pyrite in a gangue of quartz, siderite, and calcite.

ANTIMONY VEINS.

SALIENT FEATURES.

The antimony veins have a wide distribution and apparently are not connected with any single zone of mineralization, for they have various dips and strikes. All are in Prichard rocks, and their mineral composition is essentially identical. The northernmost vein, the Coeur d'Alene Antimony, strikes N. 60° E. and dips 35°–60° NW.; the Albrecht vein strikes N. 10° E. and dips 60° W.; the Pearson vein strikes N. 40° E. and is vertical; the Star Antimony vein strikes east and dips 25°–60° S. Concentrates from the Coeur d'Alene Antimony contain as high as $5 to the ton in gold, and from parts of the Star Antimony vein assays showing $8 to the ton in gold were obtained. No information was to be had as to the gold and antimony content of the Pearson and Albrecht veins. Stibnite and quartz, associated with pyrite, are the dominant minerals of the veins. Galena was nowhere observed, but sphalerite occurs rarely in the Star Antimony mine. Stibnite replaces the slate and vein quartz, its relation to the quartz being shown by small needles lining vugs in the quartz and by quartz veinlets ending against the stibnite.

COEUR D'ALENE ANTIMONY.

The Coeur d'Alene Antimony Mining Co. owns two unpatented claims (No. 25) in the SE. ¼ sec. 6, T. 48 N., R. 2 E. The property has been worked intermittently since 1885. The last work was begun in the summer of 1915, and to the present time considerable ore has been shipped. Ore to the value of $50,000 has probably been produced, though the records of the early operations are very incomplete. About 1,000 tons of stibnite ore is said to have been roasted, and the sublimed product was conveyed to a bag house and collected. This roasting plant burned down and was superseded by a concentration mill with a capacity of 75 tons a day. The concentrates were shipped in 1916 to the International smelter at Salt Lake City, Utah. The vein crops out on the west side of Pine Creek, and in the early days boulders of stibnite were worked from the creek bed. The vein occupies a fault or shear zone in black slates of the Prichard formation, which trends N. 60° E. and dips 35°–60° NW. It is exposed in surface workings for about 400 feet, and the greatest depth attained is about 170 feet on the dip of the vein. The footwall formation appears to conform with the strike and dip of the vein for the most part, but the rocks on the hanging-wall side are extremely folded and contorted and contain seams of black gouge, which in places extend into the ore. The ore ranges from less than 1 foot to 5 feet in width and consists of stibnite in a gangue of quartz and unreplaced slate. Movement along the fault fissure subsequent to the formation of the vein has greatly crushed the quartz, and much of the stibnite is ground to a slickensided black fine-grained aggregate. The ore shoot is cut off on the south by a fault containing a vertical quartz vein which trends N. 15° W. The amount of displacement is not known, as the continuation of the antimony vein has not been found south of the quartz vein. The ore shoot is said to rake to the southwest. The ore as it comes to the mill is roughly sorted by hand, the high-grade coarse material being picked out. The rest of it is crushed and passed to jigs, where three products are made. The first and second grades contain about 40 per cent of antimony; the third product, which is of lower grade, is reground and treated on Wilfley tables, but there is still a considerable loss in the tailings.

The company plans to treat the ore by fine grinding and flotation. The ratio of concentration is about 7 tons into 1, and an average of 3 tons of concentrates was being produced daily. Three cars of concentrates aggregating 80 tons were shipped in June, 1916. According to the smelter returns from a carload of concentrates shipped in April, 1916, 47,328 pounds of ore yielded 36.36 per cent

of antimony and 0.24 ounce of gold to the ton. The antimony was sold at the rate of $3.53 a unit and the gold at 75 per cent of the assay value of the ore, at $20 an ounce.

STAR ANTIMONY.

The Star Antimony group (No. 26) consists of nine unpatented claims that occupy a ridge between Stewart Creek and the east fork of Pine Creek. The ore body was discovered in 1914, but no ore shipments were made until 1916, when three carloads of ore were shipped. About 1,500 feet of development work has been done in three tunnels, the vertical range between the upper and the lower of which is 150 feet. In the lower tunnel drifts have been run on the vein for 400 feet, but the ore so far produced has been derived from the upper workings. The face of the lower tunnel is still 170 feet west of the westernmost part of the drift on the ore shoot in the upper tunnel. The vein strikes east and dips 25°–60° S. It is contained in a fault zone in bluish slates of the Prichard formation. There is much gouge material in the fissure, and the quartz is generally brecciated. Stibnite is the dominant mineral of the ore, but in the lower tunnel, as far as the vein was explored at the time of examination, it occurs only rarely as nests of needle crystals in vugs. Pyrite is rather abundant in the lower tunnel, with an occasional crystal of sphalerite, but sphalerite was not noted in the ore shoot of the upper workings. A sample across a 4-foot quartz lens in the lower tunnel is reported to have yielded $8 to the ton in gold. In both the middle and upper tunnels the ore has been stoped for about 60 feet on the strike of the vein. The ore, which has an average width of 3 feet, is contained in a fault zone whose walls are from 4 to 8 feet wide. Stibnite replaces both the slate and the vein quartz; a rich streak of crystalline though sheared stibnite, from 1 inch to 28 inches wide, occupies the center of the ore, and the poorer-grade ore consists of disseminated stibnite in the slate. The high-grade shipping ore assays 55 per cent of antimony. Some of the lower-grade material was concentrated by hand jigging to a shipping product, but there is said to be 200 tons of ore containing 20 per cent of antimony on the dumps.

PEARSON.

The Pearson prospect (No. 27) is in sec. 24, T. 48 N., R. 1 E., in a small gulch tributary to Ross Fork. The property was not being worked at the time of examination. About 50 tons of antimony ore is said to have been shipped in 1916. The openings consist of a short crosscut tunnel and drifts on the vein attaining a

length of 150 feet and a maximum depth of 50 feet. The vein is contained in a well-defined shear zone several feet wide, which trends N. 40° E. and is vertical. Thin-bedded blue and green slates are the country rocks. The vein has been stoped to the surface through a distance of 100 feet on the strike. The ore appears to be largely a result of the replacement of the sheared slates by stibnite. Quartz was not observed, but calcite crystals occur in vugs in the ore.

HANNIBAL.

The Hannibal group (No. 28) of three claims was located in 1914. It is about 1,800 feet south of the Pearson prospect. The development work comprises a crosscut of 100 feet and a drift on the vein of 150 feet. The vein trends N. 10° E. and dips 60° W. It occupies a shear zone with walls 3 feet apart in slates and a sheared greenish rock that is evidently an altered dike rock on the belt which extends between Ross Fork and the Tiberius prospect. Stibnite occurs in the shear zone in bunches and lenses, in places 6 inches thick, but no ore body of commercial size has been developed. Several tons of high-grade ore is in the bins, but no shipments have been made from the property.

A few hundred feet west of the antimony vein an inclined shaft has been sunk 60 feet in a shear zone 5 feet wide that trends N. 45° W. and dips 60° SW. The sheared rock is sparsely mineralized with galena and sphalerite.

SIDERITE VEINS.

Veins composed principally of siderite occur in the southern part of the drainage basin of the West Fork of Pine Creek. They are contained in fault fissures in Burke, Revett, and St. Regis rocks, but there is no great displacement of the strata.

PALISADE.

The Palisade Mining Co. owns 16 claims in secs. 8, 9, 16, and 17, T. 47 N., R. 1 E., on the southeasterly slope of Twin Crags (No. 29). Development work was begun here in 1910, and is represented principally by a tunnel 600 feet long on a course N. 65° W., driven to intersect several veins that crop out on the slope above the tunnel. A barometric reading at the tunnel gave an altitude of 4,140 feet. Green shales and quartzite interbedded with brown and purple quartzites of the St. Regis formation are cut by the tunnel. They strike N. 55°–70° E. and dip uniformly 25° S. The quartzitic beds contain abundantly disseminated siderite. Several dark dikes from 1 to 20 feet wide which strike about N. 30° W. and stand vertical

were noted in the tunnel section. These dikes are described on page 8. None of the veins have been intersected in the tunnel, but several crop out in places on the hillside, and abundant fragments from them are found nearly to the summit of Twin Crags. The veins are 5 feet wide in places, but none of them can be traced for any great distance, owing to the surface mantle. These veins trend northwestward, but leading into them are narrow, discontinuous stringers of iron oxides and quartz, most of them less than 1 foot thick, which trend west. The iron oxides are in the form of botryoidal limonite and magnetite, and they were probably formed by the reduction of vein siderite, but unoxidized vein matter has nowhere been disclosed. Mr. Smith, manager of the property, states that assays of the vein matter show traces of lead, a little silver, and considerable manganese.

BLACK DIAMOND.

The Black Diamond group (No. 30) of three claims is in sec. 23, T. 47 N., R. 1 E., several miles southeast of the Palisade group. The claims were located in 1913. The development work consists of open cuts and short tunnels directed on a gossan stained with iron and manganese, which strikes N. 70° W. and dips steeply north. In places the outcrop is 40 feet wide. The vein can be traced by means of fragments of gossan and an occasional outcrop toward the Palisade group, on the west. A tunnel 160 feet long with a crosscut of 35 feet explores this vein, but it attains no great depth and the vein exposed is largely oxidized. The country rock is massive white quartzite which strikes northeast and dips 30°–35° SE. The vein matter is spongy limonite and crusts of small manganese oxide crystals that inclose cores of unaltered siderite or fragments of the quartzite wall rocks. Mr. Brooks, one of the owners of the group, stated that a sample across the vein assayed 19 per cent manganese. Chalcopyrite occurs sparsely in the vein, but no lead or zinc minerals were observed. Several other veins with iron-stained cappings are on the group, but these have not been explored. The value of these veins will probably depend on the utilization of their manganese and iron content as a flux or as an ore of manganese.

EQUITABLE.

The Equitable group (No. 31) of seven unpatented claims lies principally in the SW. ¼ sec. 13, T. 47 N., R 1 E. The group is developed by a tunnel 335 feet long driven on a fissure in hard white quartzite of the Revett formation. The fissure strikes S. 65° E. and dips 75° S. It is occupied by a vein about 2 feet wide composed

mainly of coarse siderite but containing also a little disseminated pyrite and chalcopyrite. A dike of dark fine-grained olivine camptonite, 3 feet wide, disclosed about 200 feet from the portal, lies on the hanging-wall side of the fissure. The development is directed toward a point underneath a large iron outcrop on the hillside, probably 100 feet from the present face.

COLUSA.

The Colusa prospect (No. 32) is on the eastern branch of the West Fork of Pine Creek, near the line between secs. 18 and 19, T. 47 N., R. 2 E. A crosscut tunnel of 100 feet from the creek level intersects the vein, and a drift on it extends for 550 feet on a course S. 65° W. The vein occupies a fissure in massive hard quartzite and dips 60° N. At the face of the drift it is but 1 foot wide, and nowhere, apparently, does it exceed 4 feet. The walls are poorly defined. In places quartzite fragments are cemented by the vein filling of siderite and quartz. Chalcopyrite is reported to occur sparingly in the vein. At 40 feet from the portal there is a well-defined fault with gouge 3 feet thick which strikes N. 45° W. and dips 60° SW., but apparently it has not greatly displaced the formation which it cuts.

The West Colusa prospect, 800 feet downstream from the Colusa, is developed by a tunnel about 150 feet long. The vein lies in a fissure which trends N. 60° W. and dips 65° N. The vein is narrow and consists of manganiferous siderite which cements brecciated quartzite of the Revett formation. No copper or lead minerals were noted in the vein.