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GEOLOGY AND ORE DEPOSITS NEAR MURRAY, IDAHO

By
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Prepared in cooperation with the United States Geological Survey

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Philip J. Shannon

ABSTRACT

Most of the surface of the Murray district is underlain by the Prichard formation of the pre-Cambrian Belt series, which is composed for the most part of thin-bedded, dark gray argillite and slate, and lesser amounts of gray and white quartzite. On the north and west sides of the area mapped lie rocks of the Burke, Revett, St. Regis, and Wallace formations, also members of the Belt series of pre-Cambrian age. These rocks have been intruded by monzonitic rocks, diabase, and lamprophyre, although monzonitic rocks and diabase do not crop out in the area mapped. The igneous and pre-Cambrian sedimentary rocks are overlain along stream valleys and on terraces several hundred feet above the streams by unconsolidated deposits of sand, gravel, and silt of Tertiary and Quaternary age, which, because of their gold content, have played an important part in the mining history of the region.

The ore deposits near Murray include both lodes and placers. The placers have produced gold and silver worth over $4,000,000, and the lodes have produced over $2,000,000, mostly in gold. The deposits along the present streams have accounted for most of the placer production, although the terrace or bench gravels have contributed substantially. In addition to gold, the lodes have produced considerable lead and zinc from shear zones that cut the Prichard formation at steep angles. The lode gold occurs principally in quartz veins approximatively along the bedding of the Prichard formation. Some scheelite is found with the gold in the bedding deposits.

Except for areas that were overlooked—for example, the Bee Hive deposits discovered in 1881—the richer gulch placers were largely worked out in the early days. Between 1887 and 1928, most of the gravel along Prichard Creek between the Four Square mine and the old town of Raven was mined by a dredge. A large volume of unworked ground is still present along Prichard Creek between the Four Square mine and Eagle and may be possible dredging ground as a result of the increased price for gold. Most of the bench gravels remain unmined. They are large in volume, though on an average probably low in grade, but nevertheless remain as a possible source of gold by large-scale mining methods. Production on a relatively small scale can be expected in the future from the gold-quartz veins. Lead and zinc deposits occur in irregular lens-like shoots along well-defined shears in some mines, and when the price for these metals is sufficient to justify prospecting new shoots will likely be found.

INTRODUCTION

During the summer of 1935, the United States Geological Survey, in cooperation with the Idaho Bureau of Mines and Geology, undertook a reexamination of the gold-tungsten deposits near Murray, Idaho. After the price of gold was increased in 1935, both placer and lode mining near Murray underwent a marked revival, and it was hoped that a detailed study of the mines might result in a better understanding of the deposits and possibly lead to the discovery of new ore.

Ransome and Calkins \(1^1\) described the gold-tungsten deposits near Murray in

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1.
1906, and Umpleby and Jones \footnote{Umpleby, J. B., and Jones, E. L. Jr., Geology and ore deposits of Shoshone County, Idaho: U.S. Geol. Survey Bull. 732, 1925.} visited the district in 1916 and published notes on the deposits. The present publication embodies more detailed maps and mine descriptions than the two previous reports, but covers a considerably smaller area. The surface map of Hanksme and Calkins covering the Murray district is brought up to date and is changed locally in detail.

ACKNOWLEDGMENTS

The writer was ably assisted in the field work by G. D. Emigh. Julius Hall of Wallace, Idaho, gave full access to his maps and records of the mines near Murray, and assisted otherwise. William Wylie gave freely of his first-hand information pertaining to the history of mining in the Murray district, and accompanied the writer to several of the mines. Rush J. White, H. C. Stapleton, H. M. Thromson, Cliff Moore, John F. Murphy, Mike Wallely, C. J. Van Curen, Ross Roundy, John Thorkelson, Harry Mann, and Robert Martin all contributed time and information. Roger H. McConnel assisted with petrographic work and re-drafted some of the maps.

PREVIOUS WORK

A list of publications pertaining to the geology of the Murray district is not included in this report, but can be found in the bibliography for Shoshone County in the Annual Reports of the Mining Industry of Idaho by the State Mine Inspector.

GEOGRAPHY

LOCATION AND ACCESS

Most of the gold and tungsten deposits near Murray are situated in an area about 4 by 6 miles in extent. This area lies in the northeast part of the Coeur d'Alene district. The mines described are distributed in three different mining districts - Summit, Eagle, and Beaver (fig. 1). By road, Murray is about 20 miles north of Wallace, the county seat of Shoshone County. This road crosses two summits - Dobson Pass, at an altitude of 4,170 feet, and Kings Pass, at 3,921 feet. A road along the North Fork of the Coeur d'Alene River joins U. S. Highway 10 at Enaville, 32 miles southwest of Murray and 8 miles west of Kellogg. In 1955, another road was opened to Thompson Falls in Montana. This road, which crosses Thompson Pass at an altitude of 4,862 feet, was in poor condition in 1955. The narrow-gage railroad that formerly served Eagle and Murray was washed out by floods in 1953 and has not been rebuilt.

TOPOGRAPHY

The Coeur d'Alene district is characteristic by high relief. Near Murray, the ridges rise steeply 1,500 to more than 3,000 feet from the valley bottoms within horizontal distances of 1 to 3 miles. The altitude of Murray, for example, is 2,772 feet, whereas Murray Peak, about 2 miles northeast, is 5,920 feet above sea level. When viewed from a high point, however, the region has the appearance of an elevated smooth surface, and the relief is not so apparent. This surface has been dissected near Murray by Frichard and Beaver creeks and their tributaries. Both streams flow into the North Fork of Coeur d'Alene River. At least, three well-developed pediments can be clearly seen in some places within the valleys, and some of them are covered with gravel. In favorable localities, the gravel deposits have been mined for gold.
 INDEX MAP OF MINES NEAR MURRAY, IDAHO

LEGEND
- Boundary of Mining District
- Boundary of Waterline
- Boundary of area covered by geologic map
- Mines or prospect

Fig. 1. Index map of mines near Murray, Idaho
Except where forest fires have recently burned, the hills are heavily timbered (fig. 2). Where associated with thick soil or dense second growth the timber makes geologic observations extremely difficult and limits travel largely to roads and trails.

GEOLOGY

CLASSIFICATION OF THE ROCKS

The rocks of the Coeur d'Alene district have been classified by Ransome and Calkins 1 into three major groups. The first consists of pre-Cambrian rocks of the Belt series. They are the only consolidated sedimentary rocks in the district. Exposures of underlying pre-Cambrian or overlying Paleozoic rocks have not been found in the Coeur d'Alene region, although both have been found eastward in Montana. The second group consists of igneous rocks, which have intruded the rocks of the Belt series. The third group includes the unconsolidated deposits of sand, gravel, and silt of Tertiary and Quaternary age, which form patches on the eroded surface of the Belt rocks and cover the floor of the valleys.

PRE-CAMBRIAN ROCKS

Belt series

General features

The beds that make up the Belt series are composed principally of quartzite, slate, argillite, shale, and calcareous rocks of several types, which in the aggregate have a maximum thickness that probably exceeds 20,000 feet. Old as they are, these rocks in general have not undergone much metamorphism apart from areas that show mineralization.

Ransome and Calkins divided the Belt series into five formations which they named, in ascending order, Prichard, Burke, Revett, St. Regis, Wallace, and Striped Peak. Although distinct units, these formations succeed one another conformably with gradational contacts, and hence the dividing planes between them are more or less arbitrarily set. During the recent study, complete sections of the Burke, Revett, and St. Regis, and partial sections of the Wallace and Striped Peak formations, were measured in detail.

Sections of the Burke and Revett formations were measured near Glidden Lakes and on the South Fork of Pine Creek, about 20 miles apart. Although these formations differ in detail at the two places, their general characteristics are remarkably similar in spite of the fact that the Revett formation is nearly twice as thick on Pine Creek as at Glidden Lake.

Complete sections of the St. Regis formation were measured at Military Gulch and on Maple Cliff, 20 miles northwest of Military Gulch, and a partial section was measured at Twin Lakes, about 3 miles southeast of Mullan. The rocks that make up the St. Regis formation are very similar in the three localities, but at Maple Cliff the thickness is about 300 feet less than at Military Gulch.

About 2,900 feet of the lower part of the Wallace formation was measured near Twin Lakes. Another 2,700 feet was measured from the top downward on Slate Creek, about 8 miles southwest of the Twin Lakes section. An unknown thickness

Fig. 2. View looking up Pritchard Creek from Kings Pass. White material along creek is dredge tailings.

Fig. 3. Overturned and broken fold along Pritchard Creek south of Murray.
of beds lies between the measured sections, although it is not considered to be
great.

Over 1,600 feet of beds belonging to the Striped Peak formation were measur-
ed on Dam Creek, about 3 miles southeast of Striped Peak, but this does not re-
present the entire thickness of the formation.

Prichard formation

Less is known about the detailed stratigraphy of the Prichard than any of
the other formations, largely because exposures are poor. The Prichard is the
oldest and thickest formation in the Coeur d'Alene district, and its base is not
exposed.

The prevailing rock of the formation is argillite that in many places has a
distinct slaty cleavage and shows angular laminations in lighter and darker shades
of gray. Beds of gray and white quartzite are found at several horizons, but
particularly near the top where they are interbedded with thinly laminated argil-
lite. White quartzite is also found probably near the middle of the formation.
In the Pine Creek district, Jones \(^1\) has mapped a middle quartzite member that
ranges in thickness from 75 to probably not less than 550 feet. In the Murray
district, there are numerous white quartzite beds, possibly all nearly at the
same horizon, although because of faulting their positions are uncertain. About
100 feet of beds that are mostly quartzite are exposed in the Four Square mine,
and a bed about 20 feet thick is exposed on the King property northeast of the
Four Square mine and on the opposite side of Prichard Creek. Two zones of beds,
each over 200 feet thick, consisting largely of white quartzite, are also expos-
ed in the Idaho tunnel of the Golden Chest mine. Other well-defined, white
quartzite beds are exposed near the head of Butte Gulch, but they probably lie
near the top of the Prichard formation. Pyrite is disseminated through much of
the Prichard formation in the Murray district and probably accounts for the brown
stains on the surface of the rocks when they are exposed to weathering.

Calkins \(^2\) has estimated that the Prichard formation is more than 8,000 feet
thick.

Burke formation

The Burke formation contains a variety of rock types, some of which resemble
parts of the underlying Prichard and some the overlying Revett. The contact
with the underlying Prichard is sharply defined at the top of the thinly laminat-
ed beds of nearly black argillite, but the contact between the characteristic
grey shale quartzite of the Burke and the massive white vitreous quartzite of the
Revett is marked by a transition zone several hundred feet thick. In this report
the transition zone is placed with the Revett because where the rock is not ex-
posed the quartzite float of the transition zone resembles the quartzite of the
typical Revett closer than it does the typical grey, shaly quartzite of the Burke.

The prevailing rock of the Burke formation is a grey, shaly quartzite, much
of which, when exposed to weathering, breaks into thin slabs, on the parting
planes of which there is considerable light-green mica. White and light grey
quartzites occur throughout the formation, and some purplish quartzites are
found near Glidden Lakes. White quartzites are more abundant in the Pine Creek
section than that near Glidden Lakes. Two zones that consist mostly of white

\(^1\) Jones, E. L., Jr., A reconnaissance of the Pine Creek district, Idaho: U. S.
\(^2\) Calkins, F. C., op. cit., p. 29.
quartzite are very well developed on the South Fork of Pine Creek - one 400 feet thick begins about 450 feet above the base, and another of similar thickness about 1,500 feet above the base of the formation. In both zones, white quartzite is interbedded with some gray shaly quartzite. Near Glidden Lakes, about 15 feet of white quartzite occur at the base of the Burke; about 1,500 feet above the base another zone about 200 feet thick contains numerous beds of white quartzite. Most of the white quartzite has small brown inclusions of iron oxide.

Calcareous quartzite is found through much of the Burke on Pine Creek where one very calcareous zone 80 feet thick occurs about 850 feet above the base of the formation. The beds of gray shaly quartzite, 400 feet below the top of the formation, also contain many calcareous layers. All the calcareous beds weather brownish, thus indicating the presence of considerable iron. Ripple marks and mud cracks are abundant throughout the rocks of this formation.

As measured near Glidden Lakes, the thickness of the Burke formation is 1,800 feet, and, on the South Fork of Pine Creek, 2,400 feet.

Revet formation

The Revett formation is composed principally of hard, rather thick-bedded, white quartzite, but it contains also some gray shaly and sandy quartzite, and at several horizons very calcareous quartzite that weathers to a brown powder. The Burke beds grade into the typical Revett through a transitional zone several hundred feet thick, and the boundary is necessarily arbitrary. The more characteristic pure white quartzite of the Revett formation is massive, but the bedding is commonly marked by delicate fine lamination. Even the purer beds in many places have partings of less pure material; the most common impurity is pale-green sericite. As in other formations, the massive white quartzite contains numerous specks of iron oxide, which give the rock a mottled appearance if they are abundant. As pointed out by Calkins 1/, the iron oxide is partly derived from finely disseminated crystals of siderite, which can be seen with the unaided eye in many fresh specimens.

As measured near Military Gulch, the thickness of the Revett formation is about 2,100 feet, although this figure may be incorrect as the formation is here crossed by a fault. On Pine Creek, the measured section totaled over 3,400 feet. On Pine Creek, however, only a few outcrops were visible in the upper 400 feet, and float was used as a guide in determining the contact of the Revett with the overlying St. Regis.

St. Regis formation

The St. Regis formation is composed principally of shaly and sandy quartzite, indurated shale, and some calcareous beds, nearly all of which are abundantly marked by shallow-water textures such as ripple marks and mud cracks. The color of the beds is prevalently purple, although greenish beds are common. As shown by bleaching along bedding planes and fracture cleavage, much of the green coloring is the result of hydrothermal alteration that succeeded folding of the beds. The thickness of the St. Regis formation at Military Gulch is about 1,200 feet, and at Maple Cliff, 920 feet. At Twin Lakes, a thickness of 1,100 feet was measured, although the complete section is not exposed. Except where the rocks are altered, the boundaries between the Revett formation below and the Wallace formation above are marked by purple beds.

In the basal 300 feet of the Military Gulch section, beds of white vitreous quartzite alternate with purplish beds, and at Maple Cliff beds of massive nearly white quartzite alternate with purple beds as much as 400 feet above the base. Some of the quartzite beds are distinctly calcareous. At Twin Lakes, the lower beds of the St. Regis are not exposed, and green colors are more abundant than at Military Gulch or Maple Cliff. At Military Gulch, greenish-colored beds make up about one-tenth of the section, at Maple Cliff about one-sixth, and at Twin Lakes about one-third. Purple and gray beds make up the remainder. Calcareous rocks are abundant throughout the measured sections. The calcareous beds weather reddish-brown or yellowish-brown.

Wallace formation

The Wallace formation is made up of a great diversity of rock types, but with a few exceptions the beds are calcareous. Mud cracks, ripple marks, and cross-bedding are well developed throughout most of the formation and serve as a means of detecting overturned beds. Where free from alteration, the Wallace beds are characteristically white, gray, and black, in contrast with the purple and green beds of the St. Regis formation below and the Striped Peak formation above.

A complete section of the Wallace formation is not exposed in the Coeur d'Alene district. The lower part of the section was measured at Twin Lakes and near the mouth of Lake Gulch, and the upper part was measured on the slope of Foolhen Ridge on Slate Creek and near Striped Peak. The thickness and character of the beds that lie between the upper and lower parts of the Wallace formation, as measured, are not known with certainty, although the beds are probably mostly gray limy quartzite with interbedded dark-gray and black limy argillite, and the thickness is probably not great.

Near Striped Peak, the upper 500 feet of the Wallace formation is composed largely of thinly laminated, noncalcareous, nearly black argillite. Where altered the rock is greenish gray, but it usually retains the laminations. Below this argillite is about 500 feet of dark-gray impure limestone that weathers to a brick-red hackly surface. For the most part, it shows distinct bands. The impure limestone is underlain by about 500 feet of rocks similar to the upper argillite. On Foolhen Ridge, 7 miles southeast of Striped Peak, the upper argillite member is about 1,500 feet thick, the limestone about 250 feet, and the lower argillite about 1,000 feet. Below the lower argillite beds is a very thick series composed mostly of white and gray limy quartzite alternating with layers of nearly black argillite, generally limy, and some beds of impure limestone. The layers of quartzite range in thickness from about a foot to less than an inch, and the relative proportion of nearly black argillite and quartzite varies considerably. In some places, argillite prevails, whereas in other places it is present as thin partings in the quartzite. Mud cracks show best in the nearly black argillite where they are filled with light-gray or white quartzitic material. The impure limestone beds are dark-gray and when exposed weather brick-red; the weathered surfaces in most places are very hackly and pitted. Near Twin Lakes, the most limy beds occur between 1,800 and 2,000 feet above the bottom of the formation.

Where the Wallace beds have been hydrothermally altered, they show various shades of green and weather tan. At Twin Lakes, the lower beds of the Wallace formation have undergone considerable hydrothermal alteration, but near the mouth of Lake Gulch they are almost free from alteration. As in the St. Regis formation the alteration has been controlled principally by bedding planes and fracture cleavage, and where the alteration is incomplete the rock has a breccia-like appearance.
The total thickness of the Wallace beds measured at Twin Lakes, on Poolhen Ridge, and near Striped Peak, ranges from 4,500 to 6,000 feet, with an unknown thickness of beds between the upper and lower measured sections. In other words, the upper beds thicken to the southeast of Striped Peak.

**Striped Peak formation**

The Striped Peak formation does not crop out near Murray (pl. 1), but occurs at the south end of the Coeur d'Alene district, in the vicinity of the peak from which it derives its name. However, for the sake of completeness, the description of the formation is included in this report.

South of Striped Peak at the head of Slate Creek and on Dam Creek, purple and green quartzite beds of the Striped Peak formation rest on thinly laminated argillite beds of the upper part of the Wallace formation. The lower 1,200 feet of the Striped Peak formation is composed principally of alternating beds of massive purplish-gray quartzite and greenish-gray sandy quartzite with some beds of purplish-gray muddy quartzite. Above these beds lie about 350 feet of thinly laminated, mostly purplish-gray, muddy quartzite beds with some massive purplish-gray quartzite, and one zone, about 15 feet thick, of gray, very calcareous quartzite that weathers to a brown powder. Thin calcareous beds occur throughout the formation. The beds of the Striped Peak formation, particularly those near the top of the measured section, resemble those of the St. Regis formation, but, because of their stratigraphic position, they clearly lie at a higher horizon.

The thickness of the exposed Striped Peak formation, as measured, is about 1,550 feet. Above this point the sequence is interrupted by a fault of large displacement.

**igneous rocks**

**general features**

Several types of coarse- and fine-grained igneous rocks occur in the Coeur d'Alene district. Calkins has classed them as monzonite rocks, diabase, and lamprophyre. In this report, fine-grained monzonite dikes are discussed with the lamprophyres. There are several varieties in each group, particularly in the monzonite group, in which several rock types show intricate transitions.

All the igneous rocks intrude formations of the Belt series, although the sequence of intrusion is not entirely known. Calkins states that decomposed rocks similar to the lamprophyres out monzonite and that a lamprophyre dike lies parallel to the Dobson Pass fault, which is later than the monzonite. Also, most of the faulting preceded mineralization, and in most places the diabase and lamprophyre dikes do not appear to be extensively mineralized. However, some dikes such as that at the Tiger group have been fractured and largely replaced by quartz, ankerite, and pyrite. The monzonite rocks contain ore in several mines.

The monzonitic rocks are locally known as "granite". They are holocrystalline or porphyritic, coarse-grained, and light to dark gray. They occur mainly in irregular masses that crop out in a northeast-trending zone extending from the vicinity of Gem and Bradyville almost to Bear Gulch, a distance of about 12 miles.

1/ Ransome, F. L., and Calkins, F. C., op. cit., p. 44.
2/ Idem, p. 44.
GEOLOGIC MAP OF THE MURRAY DISTRICT
The diabase and lamprophyre dikes are much smaller in areal extent than the monzonitic rocks, but are more widespread. Both diabase and lamprophyre are relatively fine-grained dark rocks that in most places weather more rapidly than the sedimentary rocks, which they intrude, and hence their outcrops as a rule are very inconspicuous.

Monzonitic rocks

Although diabase and the monzonitic rocks of Calkins were not found in the Murray district, as indicated in Table 1, both crop out nearby. A body of monzonite over a mile long and half a mile wide is exposed on Granite Creek just south of the area mapped, and several smaller bodies of monzonite, and two irregular diabase dikes, occur about 1 mile east of Bear Gulch on the north side of Frickard Creek.

The several types of monzonitic rocks described here under one heading differ widely in composition and texture, yet as a result of intricate transitions almost any gradation from diorite to syenite can be found in a good-sized exposure. Nevertheless, it is probable that all were derived from the same magmatic source and during the same episode of intrusion.

The prevailing rock of the larger intrusive bodies is a coarse-grained, light gray, porphyritic monzonite with numerous nearly black glistening crystals of hornblende. Feldspar and hornblende make up most of the rock. Quartz is present only in minor amounts. Some pyroxene, epidote, and titanite can usually be seen with the naked eye. Feldspar occurs as two distinct groups of crystals. One group, composed of elongated tabular phenocrysts of microcline and microperthite, which commonly show carlsbad twinning, is set in a groundmass of smaller and more nearly equidimensional plagioclase crystals. Albite twinning shows on some of the plagioclase of the groundmass. Some of the larger phenocrysts exceed a length of 5 centimeters whereas the grains of the groundmass average about 1 millimeter. The prevailing rock of the smaller intrusive masses differs from that of the larger bodies largely in grain size. The phenocrysts are smaller and the groundmass is commonly so fine-grained that the minerals cannot be distinguished with the naked eye.

The porphyritic rocks of both the smaller and larger masses grade into rather fine and even grained, dark gray rocks without noticeable microcline and microperthite phenocrysts on one hand and into coarse-grained, light colored rocks composed largely of these phenocrysts on the other hand. With a decrease in phenocrysts, the composition of the rock approaches diorite whereas with an increase in phenocrysts the composition approaches that of syenite. Such gradations are well shown in the outcrops near Gum and in the railroad cut near the old settlement of Bradyville, about 3 miles above the mouth of Ninemile Creek.

Monzonite is the prevailing rock type of the group. It is composed largely of plagioclase with an average grain size of about 1 millimeter diameter and large phenocrysts of microcline and microperthite. Hornblende, pyroxene, quartz, magnetite, and apatite are commonly present in relatively smaller amounts whereas biotite, garnet, and zircon were seen only in a relatively few specimens. Considerable epidote, sericite, and saussurite, a fine-grained mixture of sericite and zoisite (?), and some chlorite are generally present. In mineralized areas, veinlets containing siderite, quartz, and sulphides cut the rock.

The plagioclase is zoned and the central zones are largely altered to sericite and saussurite. Because of the zoning and alteration, the composition is uncertain, but probably averages about An$_{35}$ or An$_{20}$. In marked contrast with the plagioclase, microcline is almost free from alteration. It occurs as irregular-shaped grains, but most of it is intimately intergrown with plagioclase as
microperthite. As shown by indices of refraction, the composition of the plagioclase in the intergrowths is more soda than the plagioclase without intergrown microcline. In some places where microcline has replaced plagioclase, outlines of the zonal bands of the plagioclase remain. The microperthite appears to represent a stage in the replacement process.

Hornblende is by far the most abundant ferromagnesian mineral. It is green and shows strong pleochroism from greenish-yellow to bluish-green. Generally, it is somewhat altered to epidote and chlorite. Pyroxene, when present, is so much altered to a bluish-green amphibole and chlorite that its determination is uncertain, but the green color and slight pleochroism suggest that it is probably a soda-rich variety.

Quartz generally makes up less than 5 per cent of the component minerals. It occurs in small irregular patches mostly along grain boundaries and appears to replace both plagioclase and microperthite.

Titanite, magnetite, and apatite are the common accessories. Of them, titanite is most abundant. It occurs as lance-shaped crystals that cut plagioclase and microperthite.

Diabase

Although diabase dikes were not found in the area represented in Plate 1, they are widespread in the Coeur d'Alene district. Calcins mapped one on the spur between Prichard Creek and Cement Gulch about 5 miles east of Murray and another was found in 1935 on the crest of the ridge about 3 miles east of Murray Peak. The following discussion is supplied by P. C. Calcins, who has recently re-studied the dike rocks of the Coeur d'Alene district:

"The rock at the first locality shows moderate, and that at the second very advanced, alteration. As a basis of comparison, the main characteristics of the diabase in its occurrence on Placer Creek, nearly 15 miles south of Murray, may be outlined.

The rock of the Placer Creek dike is a rather siliceous diabase, in which the chief constituents are plagioclase, largely saussuritized, in crystals of more or less tabular form, violet-brown titaniferous augite, and ilmenite in large skeleton crystals. Considerable quartz and micropegmatite occur interstitially, a little hornblende and biotite are present, and long needles of apatite pierce the other minerals. The texture tends to be ophitic, but less typically so than in diabases that contain more augite; the augite does not form large enough grains to enclose many crystals of feldspar completely and it is idiomorphic against the quartz and micropegmatite. The ilmenite grains appear in thin sections as a very characteristic element in the fabric, and retain their forms even when the diabase is greatly altered.

The rock near Cement Gulch is dark greenish-gray and finely granular. The first impression one receives on looking at a thin section under the microscope is of a general similarity in texture to the Placer Creek rock, though the minerals are blurred in outline, and the plagioclase contains many secondary inclusions, even where it is not clouded by the common saussuritic alteration products. The plagioclase is shadow-zoned, with cores near An55 and rims near An20; it is definitely, but not much, more soda than that of the Placer Creek dike. Pale amphibole has wholly replaced the augite and is edged in places with deeper-green hornblende which may be original. Apatite needles are fairly
numeros. Biotite, of a slightly greenish-brown color, is rather abundant in fine-grained aggregates enveloping ilmenite, which forms characteristic large crystals, the trigonal symmetry of which is emphasized by alteration to leucoxene along cleavage cracks.

The dike east of Murray Peak is of a more greenish-dark gray color. The thin section, under the microscope, shows all the minerals to be perfectly clean and unweathered. All of them, however, are secondary; the texture is not typical of an igneous rock, but is confused by abundant inclusions of one mineral in another. The most abundant constituent is albite near Aug. Second in abundance is deep-green chlorite, forming large felted aggregates. A good deal of deep olive-brown biotite is rather evenly distributed. A little of it has been changed to chlorite, which, however, is oriented on the parent mineral and is distinct from the felted chlorite. There is a very minor quantity of yellowish-brown mica which is distinctly biaxial. A good deal of quartz is present, and there are several areas of clear zelite, which enclose grains of all the minerals named and a little epidote. The iron ore gives a clue to the origin of the rock; it consists of groups of small grains embedded in the felted chlorite, and some of these groups form triangular patterns which suggest that they are ghosts of ilmenite crystals. This mineral occurs in the diabase, but not in the lamprophyres, which indicates that the rock was originally a diabase. The idea is confirmed by the fact that the albite shows more crystal form than the areas of felted chlorite, which are presumed to have been derived in the main from augite; the original texture, though nearly obliterated, thus seems to have been ophiitic as in diabase rather than janidomorphic as in the lamprophyres."

**Lamprophyre and monzonite dikes**

Several lamprophyre and monzonite dikes crop out in the Murray district. The two largest ones are at the Golden Chest mine and in Tiger Gulch. Others occur south of the Gold Bank vein between Cougar and Gold River gulches, at the Tiger mine, at the Anchor mine, near the Pilot mine, near the mouth of Buckskin Gulch, and in Dream Gulch.

The following account of the petrography of the lamprophyre and monzonite dikes has been contributed by F. C. Calkins:

"Classification: The dikes mapped in the Murray district consist of medium to dark gray rocks, too fine-grained to be readily identified in the field. Of the four specimens available, two from the dike in Tiger Gulch and one from that in Reeder Gulch, are monzonitic in composition, though so fine-grained that they might be called micromonzonite, and one, apparently from the same dike in Reeder Gulch, is a lamprophyre. The composition of some of the dikes is doubtful, but it seems fairly safe to say that they are all either monzonite or lamprophyre, though not necessarily of the same variety as that in Reeder Gulch. Some of them may be composite. To avoid naming them with more definiteness than is warranted, they are designated as in the above title.

One feature which all the specimens have in common is a partial or complete replacement of the original plagioclase by albite, which is exemplified in many of the lamprophyres elsewhere in the Coeur d'Alene district. This albition was not noted in the ever-generalized description of these rocks prepared for
Professional Paper 62 1/2, nor in Shannon's 2/ more detailed description of my specimens together with those later collected by Umpleby. My description failed to discriminate properly between albite and other plagioclase, and Shannon seems in some cases to have erred in calling albite orthoclase. Recent review of the slides available to Shannon, together with some from specimens recently collected by Shenon near Murray and in the Silver Belt, has led to the belief that the original feldspar in all the lamprophyres was chiefly zoned plagioclase with cores near An_{80} or even An_{70}, shading to rims of albite or oligoclase, and that the unzoned feldspar of low refractive index which predominates in many specimens is chiefly secondary albite, though it includes a subordinate amount of orthoclase.

Spessartite—One of the specimens from Reeder Gulch was collected by me and was described and figured by Shannon 2/; who classified it as spessartite. The slide shows the contact between a fine-grained and coarser portion of essentially the same composition. The only original ferromagnesian mineral in this rock is a brown hornblende usually showing good crystal form, but in places enclosing plagioclase. This mineral constitutes about a third of the rock. Pseudomorphs composed of finely felted chlorite or serpentine, probably after augite, are much less abundant. Plagioclase originally formed the greater part of the rock. The cores of much of it are replaced in great part by epidote and were once presumably calcic as in similar rocks where the feldspar is little altered. In part of the slide the plagioclase is more uniformly altered, with sericite as the chief product. Most of the feldspar clear enough for estimation of its refractive index is albite, but a little orthoclase is present. The slide contains several relatively large roundish areas filled mainly with epidote, which is associated in places with quartz and calcite; these probably filled cavities. Magnetite occurs sparingly, the grains partly in clusters; needles of apatite are moderately numerous.

Monzonite—The other specimen from Reeder Gulch, though of the usual dark gray color, is a fine-grained monzonite; the grains are nearly all less than 1 millimeter in diameter. The ferromagnesian minerals are monoclinic pyroxene and biotite, about equally abundant and making up together about a third of the rock. The pyroxene, which is slightly greenish and has an extinction angle of 44°, is probably a diopside. The biotite is very deep brown, and, unlike that in most of the biotitic lamprophyres, is considerably altered to chlorite and epidote. No hornblende is present. The feldspar, which makes up more than half the rock, is chiefly plagioclase, but orthoclase is only a little less abundant. The orthoclase is relatively clear, the plagioclase all more or less clouded with kaolin and sericite. The refractive indices of the clearer plagioclase as estimated by comparison with that of balsam indicate that it is albite, but zoning can still be observed in at least one especially cloudy feldspar crystal, which is taken to be a remnant not completely albited. A very little interstitial quartz is present. It forms micrographic intergrowths with the orthoclase along their contacts. Titanite, a mineral not identified in the lamprophyres, but characteristic of the coarse-grained monzonites farther south, is abundant and conspicuous in double-pointed crystals. Apatite also is abundant; magnetite is relatively scarce.

One of the specimens from Tiger Gulch is essentially similar to the one just described except that the plagioclase and orthoclase are both only slightly and

about equally clouded with kaolin. Albiteization is more complete in this spec-
imen than in the last; the plagioclase is well identified optically as being all
near An. Another specimen from the same gulch, though more altered in appearance,
has about the same character. It contains no pyroxene, but numerous little mass-
es of yellowish-green serpentine are probably pseudomorphs after pyroxene. No
crystals of titanite were found, but clusters of tiny grains, perhaps of TiO2 in
some form, are thought to have been derived from it. The biotite, as in many
specimens of greatly-altered lamprophyre, is of a slightly reddish-brown hue, has
dark margins, and is absolutely fresh.

Kersantite (?):- A much-altered dike, found on Aulbach's Tiger group in Tiger
Gulch, may be classed as probably a lamprophyre and possibly a kersantite.

The mineral that first seizes the attention on viewing the thin section is
the feldspar, mostly in narrow, lath-shaped crystals with a maximum length of
about 1 millimeter. Most of it is clear, though it encloses chlorite and carbon-
ate. Its refractive indices and extinction angles prove it to be dominantly
albite, though faint zoning and sericitization in a few crystals suggest that
albiteization is not quite complete. No orthoclase was identified. The only
other constituent that is recognized as having been present originally is biotite.
This mica has, however, been completely replaced, chiefly by a chlorite of an un-
usual pale reddish-brown color in large crystal units. This chlorite has the
axis X normal to the cleavage and is sensibly uniaxial and optically negative.
Its pleochroism is distinct though not strong, with the greater absorption par-
allel to the cleavage. The biotite crystallized later than the plagioclase, which
some of the brown chlorite partially encloses.

More abundant than this brown chlorite is a chlorite having a very pale green
tint and barely perceptible pleochroism, with X parallel to the cleavage instead
of across it as in the brown variety. It forms fine-grained, felted aggregates,
some of which show oblong outlines and are probably pseudomorphs after hornblende
or pyroxene. Some of these indent the plagioclase as if their parent mineral
crystallized early. This chlorite also forms irregular patches, and the feldspar
is thickly strained with particles of it.

No iron ore was recognized in the body of the rock, which is flecked with
opaque white particles. No apatite was found.

Thickly disseminated through the rock are what seem to be two kinds of car-
bonate. One (calcite ?) forms ragged grains; the other (ankerite ?) forms rhom-
bohedral crystals. A veinlet of carbonate, pyrite, and quartz crosses the slide,
and these minerals mixed in various proportions also form isolated patches.

Nothing better than a tentative classification of this altered rock seems
possible. It differs greatly from the monzonite that forms another dike in Tiger
Gulch. Plagioclase is more abundant than in typical lamprophyres, and the tex-
ture possibly suggests diabase rather than lamprophyre. The absence of even a
ghost of ilmenite is negative evidence against diabase. More positive evidence
is the former presence of abundant biotite, in large crystal units which indicate
magnetic rather than secondary origin; but again, the mica was alleliomorphic
whereas in the lamprophyres it is generally idiomorphic."

TERTIARY AND QUATERNARY DEPOSITS

General relations

The only rocks that are younger than the Belt sediments and igneous rocks
are the unconsolidated deposits of gravel, sand, and silt mentioned with the thir-
group in the classification of the rocks. Although, in comparison to the older
consolidated sediments they occupy only small areas, these Tertiary and Quaternary deposits have been of great economic importance in the Murray district, as much of the gold produced has been recovered from them.

The unconsolidated rocks near Murray include the alluvium that occupies the valley floors and terrace gravels that form irregular patches on flat ridges at several altitudes, ranging from about 200 to 1,000 feet above the present streams. (pl. 1). Glacial deposits are found in nearby valleys, but not in the area mapped. The exact boundaries of the terrace deposits are obscure because the gravel tends to creep downhill from its original position. Generally the boundaries of the valley alluvium can be more closely determined, but in places, for example in the vicinity of the Bee Hive workings, talus and vegetation obscure the contact with the older rocks on the south side of Prichard Creek, and only since 1930, when drift mines were opened, has the extent of the alluvium in that vicinity been known.

From broader studies, Calkins concluded that the highest and oldest terrace gravel is Tertiary in age, because within 25 miles to the west of the Coeur d'Alene district the valleys had nearly attained their present depth even in the early Miocene. He points out, however, that some of the gravel on lower terraces may be Pleistocene.

Terrace gravels

The terrace gravels near Murray are found at several different altitudes as irregular-shaped remnants of deposits once continuous. Only about a dozen of the remnants are large enough to map. The largest occupies a ridge top about 1-1/2 miles west of Murray. It is about 1-1/2 miles long, in an east-west direction and about half a mile wide.

The terrace deposits are made up largely of well-rounded boulders derived from the bedrocks of the district. Near Murray, many of the boulders are greatly decomposed and fall to pieces when removed from the banks. The boulders are locally somewhat cemented.

Valley alluvium

Alluvial material has been deposited along most of the streams. In places there seems to be a discordance between the size of the present stream and the width of the valley. Today, Prichard Creek, a relatively small stream, is cutting a channel into the alluvium that fills the valley even where the stream does not flow through dredge tailings. The extensive filling indicates a former period of rapid deposition, in a valley deeper than the present one, by an overwhelmed stream much larger than Prichard Creek. At some time during its history the stream was dammed, and the resultant lake was filled with silt and plant remains to form the deposits of peat now interbedded with the gravel.

The material in the lower reaches of the valleys is in general considerably more rounded than that which lies farther upstream. This condition is shown in the piles of dredge tailings in Prichard Creek. Below Murray most of the boulders are very well rounded, whereas near the upper end of the dredged ground, near the old town of Raven, the boulders are mostly subangular to angular. As pointed out by Calkins, many of the boulders in the lower parts of the streams are derived from the terrace deposits or from glacial deposits near the head of the streams and hence have been reworked at least twice.

Peat deposits containing many twigs and branches of woody material are best exposed in the drift mines along Prichard Creek, such as the Bee Hive workings about half a mile west of Murray, and in what is known as the Lower Bee Hive near the Four Square mine. The peat averages about 2 to 3 feet thick and in the mines is generally about 3 to 5 feet above bedrock. It is in turn overlain by gravel.

Near Murray much of the floor of Prichard Creek has been dredged, and today is occupied by piles of stacked boulders. In the early days of mining the ground in many of the tributary gulches was washed for gold, but, as a result of erosion and because dense timber has grown up over many of the old placer diggings during the 40 or 50 years which have elapsed, it is difficult in many places to distinguish the ground that has been worked from that which was too low in grade to be washed profitably.

STRUCTURE

As the area near Murray that contains the mines is densely timbered and underlain by a monotonous succession of similar rocks of the Prichard formation which does not contain readily traceable beds, the details of the structure could not be worked out. The largest structural feature of the district is a broad northeast-trending anticlinal fold, which is cut by many large and small faults. In places on the limbs of this broad fold there are smaller folds, some overturned and broken by thrust faults. Such folds and faults are exposed in some mines and in several places on the surface, for example, in the Golden Chest and Wakeup Jim mines and on the surface across Prichard Creek from Murray (fig.3).

Two very large faults with northerly trends that occur in the western part of the Murray district were named by Calkins the Ucely and McComber faults. Both have throw of several thousand feet. The Ucely fault is of the reverse type, whereas the McComber fault is normal. Farther east another large fault was named by Calkins the Murray Peak fault. It likewise has a dip displacement of several thousand feet where it brings Burke and Revett beds into juxtaposition with rocks of the Prichard formation. All the other faults mapped near Murray are wholly within the Prichard formation, and hence little is known about the magnitude of the movements along them.

Except the one that crops out near the mouths of Dream and Buckskin gulches and in a long crosscut between Missoula and Dream gulches, the faults have northerly trends. This fault exception, which shows as a sheared zone 150 feet wide, strikes nearly east and west, and is vertical. On account of thick overburden and dense vegetation, its relation to the McComber and Murray Peak faults is not known. From the point where the Murray Peak fault enters the Prichard formation it cannot be traced and, but appears to coincide for a considerable distance east of Murray with a wide mineralized shear zone known as the Gold Peak. In places — for example, as exposed in the workings of the Mother Lode mine — the sheared zone was silicified for widths of almost a hundred feet. The shear zone can be followed almost continuously from the East Fork of Alder Gulch to Ophir Gulch, where it ranges in width from about 20 to more than 100 feet. East of Ophir Gulch, the fault cannot be followed continuously, but is exposed in two tunnels. A tunnel in Idaho Gulch follows a sheared zone that is on the projection of the Gold Peak lode and where partly exposed by a crosscut shows sticky black gouge and sheared rock over a width of 20 feet. A similar sheared zone is cut by a long tunnel on the south side of Prichard Creek about half a mile west of the old town of Raven. The projection of this fault about a mile to the east connects with the Thompson Pass fault as mapped by Calkins. Hence, the Murray Peak and Thompson Pass faults appear to be parts of a more or less continuous crescentic-shaped fault zone.
Calkins' map of the Coeur d'Alene district shows another crescentic zone of faulting that is almost parallel to the Murray Peak-Thompson Pass fault zone and extends from the vicinity of Prichard, at the confluence of Prichard Creek and the North Fork of Coeur d'Alene River, to Mailan, where the faults that form the zone appear to merge with the Osburn fault.

ORE DEPOSITS

HISTORY AND PRODUCTION

The first discovery of gold in the Coeur d'Alene district was made on Prichard Creek by A. J. Prichard in 1879, although the first active mining began in 1883 when Prichard staked out a number of placer claims for himself and his friends. The first quartz claim near Murray, the Paymaster, now part of the Golden Chest, was located by Patrick Flynn on September 21, 1883.

The placers near Murray were rich, and with the news of their discovery many people flocked to the new camp. By 1885 several arrastres and stamp mills were treating ore from the Golden Chest, Mother Lode, Daddy, Yosemite, Occidental, and Treasure Box. However, by 1886, with the development of the enormous lead-silver deposits of the Bunker Hill and Sullivan at Wardner, and the evident existence of bodies of rich ore in the Tiger, Poorman, Granite, San Francisco, Morning, and other mines, the zone of most of the mining activity shifted to the South Fork of the Coeur d'Alene River. At this time, Murray had not reached its most productive days. In 1890, pipe lines were constructed to wash the high-bench gravels that capped the ridges near Murray, and by 1894, when the Golden Chest and Mother Lode mines were very active, the gold production of the district reached its maximum - 17,581 ounces. In 1904, a small dredge was built on Trail Creek near Delta and several lead-zinc deposits near Murray became productive. By 1911 and 1912, with the Mammoth, Pontiac (Terrible Edith), Bear Top, Paragon, Black Horse, Cedar Creek, and other nearby mines active, the production of the lead and zinc mines near Murray reached its peak, although many of them continued to produce substantially until 1933, when exceedingly low metal prices forced all to close.

During the depression of 1930, placer mining was considerably revived, and in 1933 and 1934 the Four Square, Golden Chest, Mother Lode, and Mountain Lion lode mines again were active. In 1935, however, only a small amount of work was in progress in these mines, and most of the activity centered around the placers, which were worked in a small way.

The gold produced in the Murray district, as represented in Plate 1, has come largely from placers and from quartz veins mined principally for their gold content. Very little gold has been produced as a by-product from the lead-zinc mines, although considerable silver was produced by the Pontiac. However, as this is not primarily a gold-quartz mine, the production from it is not included in the tables below, but is given on page , with the description of the mine.

The figures in the following tables for the years 1884 to 1906 are taken from the report of Ransome and Calkins , whereas those for the years 1906 to 1935 are taken from the records of the U. S. Geological Survey and the U. S. Bureau of Mines. The figures of Ransome and Calkins are taken from a table showing the production of lead, silver, and gold in the Coeur d'Alene district from 1884 to 1906. These authors state, however, that the gold there recorded was

2/ Idem, p. 82.
derived entirely from the placers and gold-quartz veins near Murray, and their figures are thus used in this report. The figures showing placer production for the years 1906 to 1935 are aggregate totals of the Summit, Coeur d'Alene, and Beaver mining districts (fig. 1), for, although the Murray district as mapped does not include the entire areas of these mining districts, practically all of the gold came from parts of these districts within the mapped area.

**TABLE 1**

Production of gold from placers and gold-quartz veins near Murray, Idaho, from 1884 to 1906.*

<table>
<thead>
<tr>
<th>Year</th>
<th>Fino ounces</th>
<th>Value</th>
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<tr>
<td>1884</td>
<td>12,500</td>
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<tr>
<td>1886</td>
<td>18,220</td>
<td>378,607</td>
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<td>1888</td>
<td>8,823</td>
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<td>1866</td>
<td>10,260</td>
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<td>1869</td>
<td>8,435</td>
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<td>8,000</td>
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<td>1891</td>
<td>10,000</td>
<td>206,700</td>
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<td>1892</td>
<td>11,000</td>
<td>227,370</td>
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<td>1893</td>
<td>14,748</td>
<td>304,841</td>
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<td>1894</td>
<td>17,581</td>
<td>362,366</td>
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<td>1896</td>
<td>16,430</td>
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<td>1896</td>
<td>17,369</td>
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<td>16,404</td>
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<td>1898</td>
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<td>1900</td>
<td>6,764</td>
<td>116,935</td>
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<td>4,918</td>
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<td>4,781</td>
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<td>7,861</td>
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<td></td>
<td>227,896</td>
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*Extracted from table in U. S. Geological Survey Professional Paper 62, p. 82, showing production of lead, silver, and gold in the Coeur d'Alene district from 1884 to 1906. The table does not list separately the silver production of the Murray district, but between 1906 and 1935 the ratio of gold to silver as produced has been about 8 to 1; hence, it is estimated that about 46,000 to 50,000 ounces of silver were produced by the placer and gold-quartz mines from 1884 to 1906. The estimated value of the silver is about $30,000.

16.
<table>
<thead>
<tr>
<th>Year</th>
<th>Placer production</th>
<th>Production of gold-quartz veins</th>
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<tr>
<td></td>
<td>Value (Fine: ounces)</td>
<td>Value (Fine: ounces)</td>
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<td>1906</td>
<td>58.20: $1,205</td>
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<td>1907</td>
<td>602.10: 10,378</td>
<td>97: 64</td>
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<td>1908</td>
<td>293.84: 6,069</td>
<td>59: 31</td>
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<tr>
<td>1909</td>
<td>560.66: 11,589</td>
<td>96: 50</td>
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<tr>
<td>1910</td>
<td>246.80: 5,081</td>
<td>34: 18</td>
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<td>1911</td>
<td>313.15: 6,472</td>
<td>77: 41</td>
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<tr>
<td>1912</td>
<td>225.24: 4,666</td>
<td>36: 22</td>
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<tr>
<td>1913</td>
<td>96.37: 1,984</td>
<td>20: 12</td>
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<td>1914</td>
<td>26.79: 554</td>
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<td>1915</td>
<td>5.12: 106</td>
<td>2: 1</td>
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<td>45.93: 949</td>
<td>9: 6</td>
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<td>1917</td>
<td>538.76: 11,136</td>
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<td>9,006.09: 186,135</td>
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<td>7,800.38: 161,234</td>
<td>1,143: 766</td>
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<td>1925</td>
<td>5,692.89: 117,672</td>
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<td>1926</td>
<td>2,217.94: 44,845</td>
<td>224: 140</td>
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<td>1927</td>
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<td>1928</td>
<td>54.77: 1,132</td>
<td>9: 5</td>
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<td>1929</td>
<td>6.75: 140</td>
<td>1: 1</td>
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<td>1930</td>
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<td></td>
</tr>
<tr>
<td>1931</td>
<td>34.26: 708</td>
<td>7: 2</td>
</tr>
<tr>
<td>1932</td>
<td>149.13: 3,083</td>
<td>27: 8</td>
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<tr>
<td>1933</td>
<td>338.66: 8,665**</td>
<td>29: 10</td>
</tr>
<tr>
<td>1934</td>
<td>613.91: 28,486</td>
<td>212: 137</td>
</tr>
</tbody>
</table>


**Estimated value of gold for 1933 at weighted price of $25.56 an ounce.
TABLE 2 (Cont'd)

Production of gold and silver from placer and gold quartz veins near Murray, Idaho, from 1906 to 1934.*

<table>
<thead>
<tr>
<th>Year</th>
<th>Total gold (Fine ounces)</th>
<th>Total value of gold</th>
<th>Total silver (Fine ounces)</th>
<th>Total value of silver</th>
</tr>
</thead>
<tbody>
<tr>
<td>1906</td>
<td>596.41</td>
<td>$11,749</td>
<td>1,664</td>
<td>$1,132</td>
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<tr>
<td>1907</td>
<td>502.10</td>
<td>10,378</td>
<td>97</td>
<td>64</td>
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<tr>
<td>1908</td>
<td>326.65</td>
<td>7,749</td>
<td>69</td>
<td>36</td>
</tr>
<tr>
<td>1909</td>
<td>560.58</td>
<td>11,589</td>
<td>96</td>
<td>50</td>
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<tr>
<td>1910</td>
<td>245.60</td>
<td>5,061</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td>1911</td>
<td>336.24</td>
<td>6,950</td>
<td>84</td>
<td>45</td>
</tr>
<tr>
<td>1912</td>
<td>226.24</td>
<td>4,666</td>
<td>36</td>
<td>22</td>
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<tr>
<td>1913</td>
<td>96.97</td>
<td>1,994</td>
<td>20</td>
<td>12</td>
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<tr>
<td>1914</td>
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<td>1915</td>
<td>130.38</td>
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<td>1916</td>
<td>46.69</td>
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<td>1917</td>
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<td>1918</td>
<td>9,008.09</td>
<td>196,135</td>
<td>2,044</td>
<td>2,044</td>
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<tr>
<td>1919</td>
<td>7,559.85</td>
<td>156,272</td>
<td>1,531</td>
<td>1,715</td>
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<tr>
<td>1920</td>
<td>4,618.70</td>
<td>26,468</td>
<td>899</td>
<td>980</td>
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<tr>
<td>1921</td>
<td>7,181.34</td>
<td>148,435</td>
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<td>1922</td>
<td>5,946.23</td>
<td>122,868</td>
<td>1,189</td>
<td>1,159</td>
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<tr>
<td>1923</td>
<td>11,833.06</td>
<td>244,590</td>
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<td>1924</td>
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<td>1925</td>
<td>6,922.89</td>
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<td>1926</td>
<td>2,311.09</td>
<td>46,779</td>
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<tr>
<td>1927</td>
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<td>1928</td>
<td>70.22</td>
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<td>1929</td>
<td>6.76</td>
<td>140</td>
<td>1</td>
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<tr>
<td>1930</td>
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<tr>
<td>1932</td>
<td>218.72</td>
<td>4,621</td>
<td>297</td>
<td>84</td>
</tr>
<tr>
<td>1933</td>
<td>890.99</td>
<td>22,714**</td>
<td>261</td>
<td>91</td>
</tr>
<tr>
<td>1934</td>
<td>2,278.14</td>
<td>79,629</td>
<td>1,219</td>
<td>768</td>
</tr>
</tbody>
</table>

Totals: 69,247.43 | 1,308,006 | 15,614 | 13,303


**Estimated value of gold for 1933 at weighted price of $25.56 an ounce.
The tables show a uniformly high gold output from 1884 to 1903, with the peak of production in 1895. Between 1891 and 1896 the Golden Chest and Mother Lode gold-quartz mines were particularly active, and their output with that of the placers brought the gold production to the highest point reached during the history of the Murray district. From 1896 the production decreased almost steadily to 1917, when, as a result of the activity of the dredge of the Yukon Gold Dredging Company on Prichard Creek, the production increased sharply. The output of this dredge, although large, nevertheless failed to bring the production up to the average for the period 1891-1896 because the quartz mines were relatively inactive during the life of the dredge. From 1926 to 1931 production reached its lowest ebb. With the depression, however, many unemployed turned to gold mining, and this influence, with the stimulus produced by the increased price for gold, caused the production after 1931 to increase again. Numerous placer miners, working in a small way, particularly along Prichard Creek, added considerable gold to the output of several reopened quartz mines. The Golden Chest and Mother Lode produced some gold, and in 1934 activity at the Four Square mine caused an increase in production. With the closing of the Four Square and Golden Chest in 1935, the lode production decreased sharply so that practically all the gold produced that year came from the small placers along Prichard Creek.

CLASSIFICATION OF THE DEPOSITS

The ore deposits near Murray fall into four structural groups: (1) Mineralized shear zones that cut across the bedding of the enclosing rock, usually at steep angles; (2) quartz veins that lie approximately along the bedding of the enclosing rocks; (3) quartz veins that lie along low-angle thrust faults; and (4) placer deposits.

Included with the first group are the deposits worked in the Pontiac, Anchor, Gold Back, Tiger, Meade, and Crown Point mines. Of these, the Pontiac, Anchor, and Gold Back are valuable for their lead, zinc, and silver contents. The Crown Point and Meade lodes are composed almost entirely of white quartz with very few sulphides, but the Tiger contains considerable pyrite though very little lead or zinc. The bedding veins are largely white quartz, and they are valuable for their gold, and in some places for their tungsten content. The veins along low-angle thrust faults are represented only by the Wakeup Jim. The ore is essentially similar to that of the bedding veins, and, like them, is valuable for its gold content.

The placers lie along the floors of stream valleys and on terraces several hundred feet above the present streams. Those that lie along the streams are known as "gulch" placers, and those on terraces are locally termed bench or "old wash" placers. The placers are worked for their gold content.

DEPOSITS IN SHEAR ZONES

Distribution

The deposits in shear zones are widely distributed and lie along faults that have northwest trends east of Murray and northeast trends west of the town (pl. 1).

Characteristics

Most of the shear-zone deposits lie along well-defined and relatively persistent faults. The ore and gangue minerals, however, are very unequally distributed along the zones of shearing. For example, at the Pontiac and Anchor
mines roughly lenticular shoots of lead and zinc ore of good grade are separated by areas on the vein that are feebly mineralized or barren. In the Gold Back lode, iron sulphides are evenly distributed through a wide silicified zone, but here the lead and zinc sulphides thus far developed are found in lenticular masses. Sufficient work has not been done on the Tiger group to determine its continuity, and the thick soil and dense vegetation hinder its recognition at the surface. The Crown Point vein appears to be large and its width constant for a considerable distance, but in places, such as the north side of Prichard Creek, quartz is practically absent. The quartz of the Meade vein is much narrower than that of the Crown Point and less persistent. However, as at the Crown Point, the fault along which the vein occurs is well defined and fairly persistent.

Essentially the same minerals are present in all the shear-zone deposits, but the proportions differ from place to place. The same order of deposition of the minerals seems to persist.

The principal gangue minerals of the shear-zone deposits are quartz, altered wall rock, and ankerite, but smaller amounts of sericite and chlorite are also present. The metallic minerals include pyrrhotite, pyrite, galena, sphalerite, chalcopyrite, sparse gold, and in the Gold Back lode small amounts of arsenopyrite are present. Quartz was the first mineral deposited. For the most part it replaced the wall rocks, but some was deposited in open spaces. Ankerite forms veinlets in the quartz. It in turn is cut by veinlets containing sericite. All these gangue minerals preceded the metallic minerals. The metallic minerals are intimately associated and appear to have been deposited in the following order, but as a more or less overlapping series: Pyrite, pyrrhotite, sphalerite, chalcopyrite, and galena. Scheelite was not found in the shear-zone deposits, although a more careful search would probably prove its presence.

Estimates of the average metal contents of the mineralized shear-zones would have little value because of the irregular distribution of the ore minerals. Some shoots are of very high grade, for example, the ore from the shoots in the Pontiac mine averaged 34.2 per cent lead, 17.6 per cent zinc, and 2.7 ounces of silver to the ton from 1904 to 1933. Bunches of high-grade lead and zinc ores also occur in the Gold Back lode, but thus far none of commercial size has been found. In general, the gold content of the mineralized shear-zones, except for the Meade vein, appears to be low.

BEDDING VEINS

Distribution

Bedding veins occur throughout the Murray district. Many have been worked, but there are many more that are too small or too low in grade to be worked. In general, it may be said that the bedding veins are roughly distributed within half a mile of the large mineralized shear zones (Pl. 1). For example, the Mother Lode, Golden Chest, Dew Drop, and Pilot veins are near the Gold Back lode, whereas the Four Square, King, Mountain Lion, Jenkins, and Gold Coin veins are situated near the Crown Point vein. In the following descriptions of individual bedding veins (pp. 28-44) the mines are described in order of their productivity.

Characteristics

In general, the bedding veins lie along the bedding of thinly laminated dark gray argillite, although where the enclosing rock is sharply folded the veins commonly leave the bedding to follow fractures (Fig. 4), for example, near the south end of the Klondike ore shoot of the Golden Chest mine the vein leaves
Fig. 4. Polished section of quartz cutting across and lying along bedding of Pritchard formation. Mother Lode mine, about 380 feet from portal of Whistler tunnel. Bedding veins on left side of picture. X 160.

Fig. 5. Quartz vein showing fold. Stope, 180 feet from portal of Idaho No. 3 tunnel, Golden Chest mine.
the bedding and enters fractures in the footwall. In most of the mines there are commonly two or more parallel bedding veins. This is particularly true where the argillite, which encloses the ore on a footwall of quartzite, lies. For example, in the Four Square and Golden Chest mines, the principal veins lie on or close to rather massive gray or white quartzite, whereas several smaller veins occur above the quartzite, in places several hundred feet above it. Most of the veins, particularly those some distance above white quartzite footwalls, have an echelon or imbricated arrangement; for example, where one of these veins pinches out another overlapping vein stratigraphically a few inches or a few feet above or below commonly becomes correspondingly wider or thinner. In general, the veins on quartzite footwalls persist for several hundred feet, whereas those in argillite above the quartzite generally do not persist far but pass to a nearby bedding plane.

Most of the veins are less than 3 feet wide, although in places, as in the Katie-Dora ore shoot of the Golden Chest mine, the quartz is said to have reached a thickness of 10 feet. Most of the veins are not accompanied by much gouge. They tend to have sharp contacts with the enclosing rocks. In the Mountain Lion mine, however, some of the ore is largely soft muddy gouge with included lumps of white quartz. Also, one of the veins at the Golden Chest mine is considerably brecciated, owing to movement along the vein after the quartz was deposited. At the Four Square mine, some soft, altered rock next to the veins apparently contains small quantities of gold.

Where the beds show folds, the veins of quartz lie parallel to the folds. Most of the veins display this characteristic, but it is particularly well shown in the Golden Chest mine, where some veins show complex folds (fig. 5). Conspicuous lamination or "ribbon structure" is another characteristic of the bedding veins. The layers are not parallel to the sides of the veins, but cut across the quartz at small angles (fig. 6). The layers that show as black streaks in white quartz are composed largely of sulphides (mostly arsenopyrite) associated with fine-grained quartz and lesser amounts of ankerite and sericite (figs. 7 and 8). These minerals lie along nearly parallel fractures that cut coarse-grained quartz. The younger and finer-grained quartz in the fractures that cuts coarse-grained quartz locally shows comb structure. Ransome 7 considered that the layering was due to successive enlargements of the fissures, whereby the quartz previously deposited was separated from the wall by a film of slate adhering to the side of the vein. Some layering may have formed as Ransome inferred, but most of it resulted from the deposition of sulphides, quartz, ankerite, and sericite in essentially parallel fractures that cut the coarse-grained vein quartz. Many thin sections of the ores show this mode of origin, whereas films of altered rock were not recognized in the thin sections. This evidence, coupled with the facts that the bedding cuts across the veins and is not parallel to the walls and that the bedding alternates back and forth with white unbanded quartz, appears to contradict Ransome's inference. Furthermore, layering was observed in the Meade and Wakeup Jim veins, neither of which is a bedding vein.

The ore minerals of the bedding veins include arsenopyrite, pyrite, galena, chalcopyrite, specularite, scheelite, and gold. These minerals rarely make up more than 5 per cent of the ore. Selenite is reported in concentrates from the Four Square vein. The gangue is principally white quartz with lesser amounts of ankerite, sericite, albite, chlorite, and epidote. The general sequence of deposition appears to have been the same in all of the deposits, although only at the Golden Chest mine was the complete sequence observed. The oldest mineral in the veins appears to be albite. It is not abundant, but was found in the vein material from the Mather Lode and Golden Chest mines. It was followed by relatively coarse-grained quartz in which the diameter of the grains ranges from

Fig. 6. Bedding quartz veins on Intermediate level of Golden Chest mine. Banding in veins is not exactly parallel with the sides of the veins.

Fig. 7. Photomicrograph of sulphides in nearly parallel fractures cutting coarse-grained quartz. Ordinary light. X 28.
Fig. 8. Same as Figure 7 but with polarized light. Crossed nicols. X 28.

Fig. 9. Photomicrograph of polished section of ore from the Mother Lode mine showing gold (white) in fractures cutting arsenopyrite (gray). X 160.
about 0.5 to 2.0 millimeters. The vein was next fractured and then followed the deposition of scheelite. Fine-grained quartz with partly developed comb structure was next introduced. The grains of the fine-grained quartz range from 0.01 to 0.1 millimeter across. This quartz fills fractures in both scheelite (fig. 14) and the coarser-grained quartz. After the fine-grained quartz, ankerite \( w = 1.70 \) and sericite were deposited. Specularite appears to have followed the ankerite and was succeeded in order by pyrite and arsenopyrite, then sphalerite, chalcopyrite, and galena. More fracturing followed the galena, and gold was deposited in and close to the fractures (fig. 9). It was found cutting all the sulphides, but occurs more commonly in white quartz.

The gold content of the bedding veins ranges from traces to as much as 10 or 20 ounces to the ton. For a number of years, about 0.85 ounce of gold to the ton was saved on the plates in the Golden Chest mill, which, because only 60 per cent of the gold was reported saved by amalgamation, would mean that the mill heads probably carried about 1.4 ounces of gold to the ton. Numerous samples cut by competent engineers in past years indicate that the vein material left in the stopes averages about 0.6 ounce to the ton. Much of the ore mined from the Mother Lode in the early days must have been high-grade. In 1891, the average toner of the ore was about 1-1/2 ounces to the ton, and in 1890 an arrastre run averaged 4.6 ounces to the ton. The ore exposed in the mine today is of considerably lower grade, although shoots of high-grade ore still exist. High-grade ore was mined from the Mountain Lion, Pilot, Buckeye Boy, and Four Square mines, although in 1934, partly on account of dilution during mining, the mill heads at the last named mine averaged only 0.17 ounce of gold to the ton.

The percentage of scheelite in the veins is small, but as it occurs in some mines in relatively pure masses, it has been hand-sorted. In 1934, an attempt was made at the Four Square mine to save the scheelite by flotation.

DEPOSITS ALONG LOW-ANGLE THRUST FAULTS

In only one deposit, the Wakeup Jim, does the ore occur along a thrust fault. In general, the dip of the fault ranges from about 10° to 30°E, but locally it steepens to 50° or 60°. The bedding in the footwall is everywhere steep, in most places nearly 90°, whereas the bedding in the hanging wall ranges from horizontal to dips of about 30°. The ore is in lenses of irregular outline along the fault, and apparently the better grade ore is in shoots within the lenslike bodies. Post mineral movement is indicated by a large nearly vertical fault that appears to displace the ore.

The ore is similar to that of the bedding veins except that layering, although present, is not conspicuous. The ore minerals are principally arsenopyrite, pyrite, galena, sphalerite, chalcopyrite, and gold. The sulphides, which occur in white quartz, rarely make up 5 per cent of the ore. The gold content of sorted ore has been relatively high. Recent shipments ranged from 1,168 to 2,089 ounces of gold to the ton.

SUPERGENE PROCESSES

Oxidation does not extend far beneath the surface in the Murray district. In places sulphides are found at the surface, but in general some oxidation extends for 50 feet or more below the surface and in places apparently as deep as 150 feet. Near the surface the gold content of the ore in most of the bedding deposits appears to have been substantially enriched; for example, most of the ore near the surface at the Golden Chest mine was considerably richer than that on the lower levels, and this general enrichment is attributed to the effects
Fig. 10. Photomicrograph of polished section of ore from the Gold Back mine showing intimate mixture of sphalerite (gray) and galena (white). X 160.

Fig. 12. Photomicrograph of thin section of part of Idaho vein from the Idaho No. 3 level of the Golden Chest mine, showing reticulated quartz veinlets through quartzite, which is impregnated with sulphides and gangue minerals. Crossed nicols. X 20.
of oxidation and enrichment. Shoots of high-grade hypogene ore, however, occur throughout the veins at the Golden Chast mine, even to the lowest level, which is about 600 feet below the surface. Some oxidation is present on the Slab tunnel of the Mother Lode mine, about 200 feet below the surface, but it may have taken place since the level was opened. On the levels that are now open in the Mother Lode mine west of the Gold Back lode there does not appear to be much oxidation and supergene enrichment, yet there are very definite shoots of high-grade ore in the veins. Oxidation is apparent in the shallower workings of the Mountain Lion, Four Square, King, Gold Coin, and Wakeup Jim mines.

GENETIC RELATIONS OF THE DEPOSITS

The structure, texture, and mineralogy of the bedding-plane and shear-zone deposits differ considerably.

Structurally, the bedding veins lie approximately parallel to the bedding of the enclosing rocks, whereas the mineralized shear zones cut the bedding of the enclosing rocks at wide angles. Furthermore, although the bedding veins nearly everywhere show layers of quartz separated by thin films of sulphides, the shear-zone deposits do not show layering, but contain bodies of massive or disseminated sulphides. The quartz of the two types of deposits also shows a marked difference in appearance. That of the Gold Back lode is bluish-gray and has a greasy luster, whereas that of the bedding veins is nearly milk-white.

Both types of deposits carry essentially the same minerals, but generally in vastly different proportions. Scheelite, for example, is relatively abundant in the bedding veins, but was not found in the shear-zone deposits, and pyrrhotite is abundant in some shear-zone deposits, but is not known to occur in the bedding veins. Arsenopyrite, the most common sulphide in the bedding veins, was found only sparingly along mineralized shear zones. The minerals that are common to both types of deposit, however, appear to have been deposited in the same sequence.

Only in the Mother Lode mine were the bed veins and mineralized shear zones seen together. In the Arrastre tunnel, about 240 feet from the portal, small quartz stringers of the Mother Lode vein cut quartz of the Gold Back lode. The stringers in turn are cut and displaced by faults in and parallel to the Gold Back lode. The apparent vertical displacement of the Mother Lode vein along these faults is about 95 feet. The same relation is shown on a small scale on the south wall of the Arrastre tunnel, 250 feet from the portal (fig. 15). This relation indicates that at least part of the mineralization of the Gold Back lode preceded that of the bedding veins and that movements along the shear zones were recurrent after the formation of the Mother Lode vein.

Some differences, particularly in mineralogy, are apparent even in deposits of the same group. The quartz of the Meade and Crown Point shear zones, for example, is more like that of the bedding veins, and, although the structural setting of the shear-zone deposits is entirely different from that of the bedding veins, it is possible that the Meade and Crown Point veins are closely related in origin to the bedding deposits.

There are also notable differences in mineralogy between the shear-zone deposit of the Gold Back Lode and those of the Pontiac and Anchor mines. The Gold Back lode contains much pyrrhotite and relatively small amounts of galena and sphalerite, and the Pontiac and Anchor mines contain considerable galena and sphalerite, but practically no pyrrhotite. These differences in composition are believed to be due in part at least to the existence of more favorable conditions for deposition during certain stages of mineralization in one deposit than in
another; for example, it is suggested that the more persistent shear zone of the Gold Back lode permitted more direct access of solutions and therefore the de-
position of minerals at higher temperatures than did the shear zones in the
Pontiac and Anchor mines. As a result, more pyrrhotite and less galena and sphal-
erite were deposited in the Gold Back mine, whereas at the Pontiac and Anchor
mines more galena and sphalerite and less pyrrhotite were deposited.

EPITOME OF MINERALIZATION

At some time following the solidification of at least the outer part of the
granitic rocks of the Coeur d'Alene district, solutions moving upward along shear
zones in the Murray district at first deposited quartz and sericite. Quartz was
by far the most abundant and not only filled open fractures, but extensively re-
placed the rocks along the shear zones. The quartz was fractured, and pyrrhotite,
pyrite, sphalerite, chalcopyrite, and galena were introduced into the silicified
areas. Thus, the more readily accessible shear zones, such as those of the Gold
Back, Pontiac, and Anchor mines, were filled with relatively impervious material.
At some time later, possibly during the same period of mineralization, hot solu-
tions were again forced upward, but because the shear zones previously mineralized
were no longer readily accessible, the solutions principally followed other shear
zones - for example, those in the Meade and Crown Point mines, and in places along
some of the more open bedding planes. As they moved through these openings,
the solutions first deposited albite and then coarse-grained quartz. This quartz was
succeeded by scheelite, finer-grained quartz, ankerite, sericite, sulphides, and
gold. Some of these later minerals made their way into the first mineralized
shear zones - for example, arsenopyrite and gold were deposited in the Gold Back
lode - and in places later minerals filled fissures that cut the older mineralized
shear zones. Adjustments continued along the first mineralized shear zones even
after the later mineralization, and in places these adjustments caused displace-
ments of the younger deposits. Erosion finally exposed the veins, and they were
attacked by weathering. However, as erosion progressed about as fast as oxidation,
fresh sulphides are today exposed in places at the surface. During oxidation,
circulation of ground water carried some metals, including gold, downward in
solution to enrich the shallow weathered parts of most of the veins.

PLACER DEPOSITS

The gold-bearing placers of the Murray district fall into two classes; (1)
Bench gravels now several hundred feet above the present streams, which are rem-
nants of former stream deposits, and (2) alluvial deposits along the present
stream beds. Those along stream beds, commonly termed gulch placers, have been
richer and were the first to be worked. They apparently have been largely ex-
hausted, but, on account of the soil and dense timber, it is difficult in many
gulches to distinguish the worked-over ground from that which was of too low grade
to be worked by the early miners. Large areas of unworked bench gravel remain in
the Murray district. Detailed descriptions of individual placer mines are not
given in this report.

More than a dozen large areas of bench gravel, or "old wash", cap ridges
from 200 to 1,000 feet above Prichard Creek. The largest of these areas, about
a mile long by half a mile wide, caps a pediment-like surface between Dream and
Penny gulches. In places, this gravel is nearly 300 feet thick, although good
exposures are now rare. The gravel of the "old wash" is poorly assorted, but the
largest boulders occur near the bottom. Some of the boulders are 5 or 6 feet in
diameter, but most of them are less than one foot. Both granitic and sedimentary
rocks of the types found near the Murray district were noted. Most of the gold
in the bench gravels is on or near bedrock, although in some places considerable

23.
is reported to have been found as much as 10 feet above it. The gold has probably been derived from the nearby quartz veins and stringers that are so numerous in the Prichard formation near Murray. According to Mr. Walter Keistner, who purchases much of the gold mined near Murray, the fineness of the "old wash" gold ranges from about 0.825 to 0.850.

Gulch placers near Murray have been much more productive than the bench gravels. Part of the gold in them was derived from the bench gravels and part from the gold-bearing veins and stringers in bedrock. As pointed out by Ransome and Calkins [2], the gulch placers represent the final stages in the process of natural concentration and therefore were far richer than the bench gravels. Gold occurs in the gulch gravels along the bottoms of streams and in the older valley fill into which the present streams are now cutting. The older valley fill along Prichard Creek, for example, in places extends 40 feet below the present stream. This fill is made up of gravel and sand interbedded with layers of peat and some clay. In both the upper and lower Beehive workings, beds of peat from 30 inches to 3 feet thick overlie gravel from 3 to 5 feet above bedrock. In general, the thickness of the alluvium along Prichard Creek ranges from 25 to 40 feet. In the tributary gulches, it is considerably less. The boulders in Prichard Creek below Murray are mostly well rounded, whereas above Murray they become progressively more angular until they are definitely subangular near the old town of Raven. In tributary gulches, particularly where much of the material was derived from the old bench gravels, the boulders are well rounded.

The gold along Prichard Creek is relatively coarse, and most of it is found on or near bedrock. In both the upper and lower Beehive workings, it is in the gravel that underlies a bed of peat. The peat bed is used for the hanging wall of the drifts. In the Lower Beehive, the gold is well rounded and about the size of wheat, although nuggets have been found that weigh an ounce, whereas in the Upper Beehive the gold in general is more angular and the nuggets larger. In 1935, a nugget weighing 9 ounces and 7 pennyweight was found in the Upper Beehive. In September, 1936, James Clark found another that weighed 19 ounces and 16 grains that sold for $542. In 1935, several good-sized nuggets and lumps of scheelite were found in Prichard Creek, just below the Golden Chest mine. Ransome and Calkins [2] report that a nugget weighing 33 ounces was found in Buckskin Gulch and anotber weighing 29 ounces on Trail Creek. The gold of nearly all the large nuggets contains considerable attached quartz.

The fineness of the gold along Prichard Creek is generally lower than in the bench gravels. It ranges from 0.770 to about 0.830. In 1922, the Yukon Gold Dredging Company reported the fineness of their gold as 0.813. On Trail Creek and its branches, which contained some of the richest gravel formerly worked, the fineness appears to be a little higher. In 1906 and 1909, the Black Hill Placer Company near Delta reported a fineness of 0.838.

OUTLOOK FOR THE DISTRICT

The mines of the Murray district have produced about $6,225,000. Of this, more than $4,000,000 probably came from placers. Lead and zinc deposits, principally the Pontiac, have yielded about $200,000. Gold-quartz veins have yielded most of the remainder, approximately $2,000,000. With such a substantial production from lode deposits distributed over a considerable area of poor outcrops, densely covered by forests, it is reasonable to expect considerable production in the future from lodes at present unknown.

The bedding veins of the Murray district have produced substantial amounts of gold and some tungsten, and, although it seems that the richest and most readily available ore has been mined from these deposits, they should yield considerable production in the future. Very little ore is now actually blocked out in any of the bedding veins, in the strict sense of the term, yet on some levels of several mines veins have been followed for several hundred feet, and with raises a considerable tonnage might be blocked out. Also, in some mines there is a chance for developing new ore bodies. This possibility is discussed for the Golden Chest mine on pages 29-30.

Some of the bedding veins near Murray are very flat and others are much faulted, and in these deposits the mining costs will be high. However, if the veins are large enough or high enough in grade, these disadvantages can be overcome. Where the bedding has a constant dip and strike there is no particular reason to expect the veins to widen with depth. However, on folds the veins are likely to widen locally.

When the prices of lead and zinc are high enough to encourage prospecting, the lead and zinc mines near Murray can reasonably be expected to produce. The shear zone at the Pontiac mine is well defined, and ore of good grade occurs along it in irregularly shaped lenses. New lenses should be discovered with sufficient prospecting. The grade and character of the ore thus far mined can be expected to continue for at least several hundred feet deeper than the lowest existing level, if it is not cut off by faults.

The mineral composition of most ore deposits varies from place to place and with depth. Similar changes, except in reversed order, ordinarily take place outward from centers of mineralization. Some minerals form at high temperatures and others form at lower temperatures. During a single period of mineralization the minerals that form at the highest temperatures should be deposited first and should be found in the deepest parts of the deposit. From observations of many ore deposits and from experimental data, a series of changes, not invariably present in any one ore deposit, is now recognized. For the same reasons, certain minerals are accepted as indicators of high temperature and pressure conditions during deposition, whereas others are accepted as indicating intermediate and still others low temperature and pressure conditions. Pyrrhotite is commonly recognized as a mineral formed at relatively high temperature, whereas sphalerite and galena normally form at lower temperatures. It therefore follows that, unless there is more than one period of mineralization in a lead-zinc deposit, pyrrhotite, if present, should become more abundant with depth and galena and sphalerite should become less abundant. Changes of this sort are known to have taken place in the Coeur d'Alene district. Pyrrhotite, pyrite, and sphalerite became increasingly more abundant and lead less abundant on the lower levels of the Tiger-Poorman. Similar changes took place on the lower levels of the Standard-Mammoth and probably at the Helena-Frisco. It would seem, therefore, that with depth similar changes in the minerals of the Gold Back lode may be expected.

Supergene enrichment has benefited the ores of the bedding veins for an unknown distance below the surface, but it is believed that little change in the metal content of the ore will take place from this cause below depths of 200 or 300 feet. High-grade hypogene shoots occur in the deepest workings in the district and will probably continue to occur for a considerable distance below the lowest levels now opened. Because scheelite is generally considered as a mineral formed under conditions of relatively high temperature, it should persist downward, and possibly the content may increase.

The rich gulch placers near Murray are largely worked out, although, as shown by the discovery of the Beehive deposits in 1931, it is still possible to find rich deposits of this type. To judge from records of production, Prichard Creek was high-grade dredging ground. A considerable volume of undredged gravel still remains in Prichard Creek below the Four Square mine and in Eagle Creek near its mouth. The writer knows nothing about the gold content of this gravel, but it seems reasonable to expect considerable gold for some little distance below the Four Square and King veins. The Lower Beehive mine, just above the Four Square mine, is rich enough to mine by drift methods, so that the ground in that vicinity at least should be high-grade dredging ground. The placers of Daisy and Fancy gulches were rich, and considerable gold from them must have been deposited in Eagle Creek. Even though the gravel in Prichard Creek below the Four Square mine and near the mouth of Eagle Creek was not rich enough to dredge in 1926, it is possible that the increased price of gold since that time may have raised the value sufficiently to make the ground workable.

Very large areas of bench gravels remain in the Murray district. In the past they were worked fairly extensively, and in 1935 a little work was done on them. In general, the gold content of these gravels is low, but apparently in places it has been rich enough to permit drift mining. Presumably most of the gold in them lies near bedrock, and, because the gravel in places is very thick, a large volume of ground would have to be removed to liberate the gold by other than drift mining. The process of bringing water to the bench gravels by ditches would be laborious and expensive, and water for hydraulic mining is not abundant in nearby streams except during the flood season. As some of the gravel is relatively well cemented, a strong head of water would be required to disintegrate it; in places, blasting would be necessary. Nevertheless, in spite of these difficulties, the bench gravels are a possible source of gold production by large-scale mining methods.

GOLD MINES AND PROSPECTS

GOLDEN CHEST MINE

Location and development

The Golden Chest, the principal gold mine in the Murray district, is in Reeder Gulch, about 1-1/2 miles southeast of Murray. The property is opened by many tunnels, only parts of which are now accessible. Old maps show over 13,000 feet of drifts and crosscuts, in addition to many hundreds of feet of raises and winzes. In addition to the two main stopes, each about 250 feet long, there are numerous smaller stopes. The principal level in the mine, known as the Idaho No. 3 tunnel (Fig. 11), is more than 3,000 feet long, and, including drifts and crosscuts, is nearly 4,000 feet. The Intermediate level, 85 feet vertically above the Idaho No. 3 level, has been run on the Klondike ore shoot for about 200 feet. The level next above the Intermediate, known as the Pettit tunnel, was run from the surface, but in 1935 could only be reached from the Idaho No. 3 or from the Martin level above it. A total length of about 2,600 feet of drifts and crosscuts has been driven on the Pettit level. The highest accessible level is known as the Martin tunnel; in 1926, only 460 feet of a total of about 2,600 feet was accessible. Except for about 100 feet of the Idaho No. 1 tunnel, all the other workings are inaccessible.

History and production

The Golden Chest group is a consolidation of numerous claims located by several individuals. The group includes the first quartz claim recorded in the Murray district, the Paymaster, which with the Golden Chest and Katie Burnett
GOLDEN CHEST MINE WORKINGS
MURRAY, SHOSHONE COUNTY
IDAHO

LEGEND

- Ore shoot boundary
- Ore shoot boundary, Projected
- Stope outline
- a Raise
- b Winze

Note: Map traced from Company's map and slightly modified

Fig. 11. Map of Golden Chest mine workings
claims were located in the fall of 1863. In May, 1864, the Golden Chest Mining Company was incorporated. It was the first company incorporated to operate in the Coeur d'Alene district. Although reorganized several times, this company operated for many years. About 1916 Samuel Green acquired the property, and in 1935 it was owned by his heirs, although it was at that time leased to the Golden Chest Leasing Company.

The total production of the Golden Chest is large, although statistical data on the early production are not available. According to William Wylie, who operated one of the Golden Chest mills for many years, the property has produced about $1,400,000, mostly in gold, although a number of small shipments of scheelite have been made.

Geology

The rocks at the Golden Chest mine consist largely of dark gray argillite interbedded with white and gray quartzite and belong to the Prichard formation. Near the portal of the Idaho No. 3 tunnel these rocks are cut by a diabase dike. Workings of the Golden Chest explore two types of ore deposits - (1) quartz veins approximately parallel to the bedding of the argillite, and (2) fine-grained vein quartz, which, with ankerite, sericite, pyrite, and small amounts of gold, cements and replaces fractured quartzite.

A large lode-like deposit of the mineralized quartzite known as the Idaho vein stands as a bold outcrop on the hill above the Golden Chest workings and is exposed for about 900 feet along the Idaho No. 3 tunnel. As exposed along the Idaho No. 3 tunnel, the lode strikes about N. 15° E. and dips 50° - 60° N.W. On the footwall side it grades into less mineralized quartzite, but the hanging wall is marked by dark gray gouge from a few inches to more than 2 feet thick. The lode is a sheared and shattered zone, cutting white and light gray quartzite into which variable amounts of quartz, ankerite, sericite, and sulphides have been introduced. The introduced minerals occur principally along tiny veinlets, but near them (Fig. 12) the quartzite is partly replaced. Where the quartzite is least altered it is composed of a mosaic of irregularly-shaped quartz grains about 0.04 millimeter in diameter, some grains of albite (Ang), considerable shredded sericite, a little ankerite, and scattered crystals of pyrite, zircon, and apatite. Some tiny veinlets of quartz with grains from 0.01 to 0.07 millimeter in diameter cut this rock. Where the mineralization was more intense the quartzite, although still retaining many of the characteristics of the less altered rock, is cut by a regular stockwork of tiny veinlets containing quartz, ankerite, sericite, and pyrite. Pyrite occurs for the most part along the walls of the veinlets in the quartzite rock.

Two small stopes were opened on the Idaho vein in 1934-35, and the ore from them was treated in a small flotation mill near the portal of the Idaho No. 3 tunnel. Little was learned about the ore from the stopes except that it was relatively low in grade and that because of mechanical difficulties the mill made a rather poor saving. However, a few assays of samples cut from the vein were made available to the writer through the courtesy of Rush J. White. They may not show the average gold content of the vein, because obviously in deposits like the Idaho vein many closely spaced samples must be taken to determine such an average, but they give an idea of the common range of the gold content. The samples were cut across widths of 30 to 60 inches and their gold content ranged from 0.062 to 0.186 ounce to the ton.

1/ White, Rush J., private report.
2/ Wylie, William, personal communication.
In general, the bedding veins conform closely to the bedding in the enclosing rock, but locally where the rocks are sharply folded the veins cut the bedding. In places the veins also have been folded and faulted. Most of the production of the bedding deposits has come from a vein known as the Katie-Dora, although some ore was stopped from a series of small veins near the portal of the Idaho No. 3 tunnel. The latter veins have been folded and apparently overthrust from the west, as they are greatly contorted and broken (fig. 5). On the west limb of the fold, where the attitude of the veins is more uniform, they strike about N. 15° E., and dip 60° N.W.

The Katie-Dora vein is about 2,500 feet north of the small veins just described and apparently several hundred feet lower stratigraphically. This vein occurs in thin-beded, dark gray argillite on a few feet above a footwall of gray quartzite. Within a stratigraphic distance of 70 or 80 feet above the vein there are other veins in thin-beded argillite. Two ore shoots, the Klondike and Katie-Dora, have been mined on the Katie-Dora vein and have stopes lengths between 200 and 300 feet. The Klondike shoot was staked from the Intermediate level to the surface along a stope distance of approximately 500 feet (pl. 2). The Katie-Dora shoot is no longer open, but old maps indicate that it was staked from the Fettit level to the Katie No. 2 level and probably to the surface for a stope length of about 800 feet. The shoots occur in pitching folds, the Klondike on a pitching syncline and the Katie-Dora on the limb of a pitching anticline. The limb of the syncline at the south end of the Klondike shoot is very sharp, and in many places the quartz leaves the bedding to follow fractures that cut the sharp fold. On the Idaho No. 3 level, the lowest level at the north end of the mine, the exposed vein is in the quartzite series that forms the footwall of the veins on the levels above. In the Klondike shoot the thickness of quarts ranges from less than an inch to more than 5 feet. Ransome reports a range from a few inches to 10 feet, and it is assumed this maximum thickness applied to the Katie-Dora shoot, which was accessible at the time of his visit.

The veins contain both layered and massive white quartz. In general, where the veins cut the bedding, the quartz is massive and where the veins lie along the bedding it is layered, but exceptions to both cases are common. Quarts that is layered may grade within a few feet into white quartz with fer if any layers. In addition to the quartz, the gangue minerals include ankerite (w = 1.69 to 1.71), sericite, chlorite, and a little albite (Abg) and apatite. The ore minerals are principally pyrite, arsenopyrite, galena, chalcopyrite, specularite, scheelite, and gold. Free gold can not be seen in most of the ore, but bunches of high-grade ore with considerable visible gold are found. So far as known, scheelite has been found only in the Klondike shoot and only as irregular bunches. Albite occurs in very small amounts and appears to be the oldest vein mineral. It was followed by quartz with grains as much as 2 millimeters across. This quartz was fractured, and scheelite was deposited in and along the fractures. The scheelite in turn was fractured and quartz veinlets from 0.01 to 0.05 millimeter across were introduced (fig. 13). The fine-grained quartz was then fractured, and ankerite was deposited in and along the fractures. It in turn was cut by veinlets of sericite. The sulphides followed the sericite in order, pyrite and arsenopyrite first, then chalcopyrite, galena, and scheelite. More fracturing followed, and gold was deposited in the fractures. Specularite occurs in the quartz, but it is later than ankerite, and its relation to the ore minerals is not known.

The gold content of the veins, even within shoots, appears to have a wide range. According to Ransome, the tenor of the ore sent to the mill at the time of his visit was 0.35 ounce to the ton, but he states that the ore formerly mined contained 5.5 to 4.5 ounces to the ton. According to Mr. Wylie, who operated

Wylie, William, personal communication.
Fig. 13. Photomicrograph of thin section of vein specimen from the Idaho No. 3 level of the Golden Chest mine, showing quartz veinlets (white) cutting scheelite (gray). Ordinary light. X 28.

Fig. 14. Scheelite (e) in quartz vein on Idaho No. 3 level of Golden Chest mine. Hatchet in lower right corner indicates scale.
one of the mills for many years when the Golden Chest mine was being actively
worked, 0.85 ounces of gold to the ton was saved on the plates, although some of
the ore ran much higher. For example, a carload lot that was shipped directly to
the smelter returned 15 ounces to the ton. Mr. Wylie also reports that John
Chummel put 20 tons of ore through a 5-stamp mill daily, and from it he recovered
from 18.5 to 20 ounces a day. In 1916, Rush J. White sampled most of the ore ex-
posed at that time in the Klondike shoot and about 150 feet along the Katie-Dora
shoot on the Pettit level. His samples of the Katie-Dora shoot, which ranged in
width from 9 to 25 inches, assayed from 0.105 to 0.579 ounce in gold to the ton
and averaged 0.359 ounce across an average width of 14.4 inches. In 1916, Mr.
White estimated from numerous samples that the ore then remaining in the Klondike
shoot between the Intermediate and Pettit levels averaged 0.566 ounce of gold to
the ton across an average width of 25 inches. From Mr. White's assays the gold
content of the vein on the Idaho No. 3 level within the limits of the Klondike
shoot appears to be about the same as on the Pettit level. Also, as on the upper
levels, the vein carries bunches of very high-grade gold ore. In 1934, a bunch
of ore probably carrying several hundred dollars in gold to the ton was found in
the small stope above the Idaho No. 3 level at the point marked X (pl. 2), where
the vein makes a rather sharp bend. Assays of a few pieces of the veins, picked
by the writer from the stope near the portal of the Idaho No. 3 tunnel, ran from
0.687 to 1.20 ounces of gold to the ton.

Scheelite occurs in massive white quartz on the Idaho No. 3 level about 80
feet northwest of the Klondike raise (pl. 2) and is reported by Mr. White to occur
just above the Intermediate level. The scheelite occurs in irregular bunches
that range from the size of a man's fist to masses 2 feet thick, 5 feet wide, and
10 to 12 feet long. The large masses are uncommon. Mr. White states that the
clusters and bunches of scheelite lie in the veins with the long axes parallel to
the dip. In 1935, several small bunches of scheelite were exposed in the small
stopes about 60 feet northwest of the Klondike raise. The bunches were pale brown
and from 3 or 4 inches to about a foot long (fig. 14). They were both enclosed
and cut by white quartz. The percentage of scheelite in the vein appears to be
small, but because it occurs in relatively pure bunches it can be readily sorted
to a shipping product containing 65 per cent tungsten trioxide.

Suggestions for prospecting

The Golden Chest mine has produced a large tonnage of ore of good grade. Most
of the production has come from the Katie-Dora and Klondike shoots in the Katie-
Dora vein. The Klondike shoot is largely stope below the surface to the Intermedi-
ate level 85 feet vertically above the Idaho No. 3 level (pl. 2). Very little ore
has been stope below the Intermediate level. The Katie-Dora shoot has been stope
down to the Pettit level 223 feet vertically above the Idaho No. 3 level. Old
maps do not show stope below the Pettit level. Above the Intermediate level the
veins lie in thin-bedded argillite, which overlies quartzitic rocks. The Katie-
Dora vein immediately overlies the quartzite series. The vein exposed on the Idaho
No. 3 level is in the footwall quartzite. Therefore, if prospecting is renewed at
the Golden Chest, the short crosscut shown at the northwest end of Section A-A on
plate 2 should be extended until it cuts the thin-bedded argillite that contains
the Katie-Dora vein on the levels above. It is possible that ore does not occur
at this horizon on the Idaho No. 3 level, but this question can only be answered
satisfactorily by extending the crosscut or by drillings; since the thin-bedded
argillite should be found within relatively a few feet, crosscutting would prob-
ably be most satisfactory.

\* White, Rush J., private report.
The Katie-Dora shoot has not been found on the Idaho No. 3 level, although it may extend as far downward as this level. If so, it should be found from 100 to 200 feet ahead of the north face of the Idaho No. 3 tunnel. However, because a more productive horizon may be found to the west of the vein now exposed on the Idaho No. 3 level, the crosscutting mentioned above should be undertaken first. If a good vein is found above the quartzite beds, it should be followed northward to the Katie-Dora shoot. If it is not found, the stringers in the present face of the Idaho No. 3 tunnel should be followed northward, but when the projection of the Katie-Dora shoot is reached, crosscuts should be driven both east and west to prospect for parallel veins.

Assays indicate that the closely spaced veins near the portal of the Idaho No. 3 tunnel are of good grade. The Samstag tunnel is now saved at the portal, so nothing is known about its present condition beyond the portal. If the workings are as shown on old maps, the small veins exposed on the Idaho No. 3 tunnel have probably not been found in it. A crosscut from the end of the drift that follows the east side of the dike shown in Figure 11 should reach the projection of these veins within 50 or 100 feet, although the rocks in the vicinity of the stopes on the Idaho No. 3 level are considerably folded, and a projection for even a vertical distance of 115 feet is hazardous.

The Idaho vein or lode is a large body of low-grade material. Its value can only be determined by careful sampling. If sampling on the Idaho No. 3 level shows that the lode contains enough gold to constitute ore, then further prospecting both above and below the No. 3 level may be warranted.

MOTHER LODGE MINE

Location and development

The Mother Lode mine is on the south side of Prichard Creek, about a mile southeast of Murray. Numerous drifts and crosscuts at several levels have been driven on the property, but in 1935 only six levels were open. The camp contains a flotation mill, compressor house, and blacksmith shop.

The Whistler tunnel is about 870 feet long, and from it two crosscuts about 150 feet long have been driven southeast. Above this tunnel there are several connected stopes with an aggregate length of almost 200 feet (pl. 3). On the Arrastre level there are about 850 feet of drifts and crosscuts and one small stope. This tunnel is connected by a raise with a small intermediate level about 14 feet above it and by a winze with the Slab tunnel 96 feet below it. In 1938, the Slab tunnel was saved near its portal and could only be reached through the winze from the Arrastre level. A drift on it was open for 330 feet. Above the drift are extensive flat stopes. The Occident tunnel is 520 feet long, and from it drifts have been driven 80 feet northwest and 140 feet southeast. The Occident level is connected by a raise with the Intermediate level, 16 feet above it. Filled stopes for 170 feet from the portal of the Occident level indicate that the vein has been mined both above and below, and, although no longer accessible, it is quite likely that these stopes connect with those near the portal of the Slab tunnel. The Moco tunnel, not shown in Plate 3, is several hundred feet northwest of the Whistler tunnel. It is open for 350 feet to a point where a cave blocks it.

History and production

The present Mother Lode group of claims was first located and worked as the Yosemite, Daddy, Treasure Box, Mother Lode, and Occident mines. The first location was in 1863, but the mines were most productive in 1892-93 (1). At first, the ore was treated in arrastres, and several continued in use until about 1892 although

1 Wylie, William, personal communication.
MAP OF MOTHER LODE MINE
Stamp mills were also used. The total production of the Mother Lode group is not known. In 1906, Ramsome stated that the Yosemite claim had produced $600,000, but he does not report the total production of the other claims of the group. He does state that in 1887 the Treasure Box was producing as much as $10,000 a week.

Geology

Most of the production of the Mother Lode group has come from three veins, known as the Mother Lode, Daddy, and Meade. Some work also has been done on the Gold Back lode (pp. 43-44). The Mother Lode and Daddy veins are relatively flat bedded deposits of the type most common in the Murray district, whereas the Meade and Gold Back shear zones cut the bedding at a steep angle.

The Meade vein is no longer well exposed, but its strike in the Meade tunnel ranges from approximately north to N. 20° E., and its dip ranges from about 70° E. to 90° E. The quartz of the Meade vein is associated with considerable gouge and shearing. Most of the exposed quartz is white and rather massive, but some of it shows layers of sulphides. The sulphides are principally galena and pyrite, though some chalcopyrite and sphalerite also occur. According to Ramsome, the vein furnished most of the production of the Yosemite claim and was rarely more than a foot wide.

The Mother Lode and Daddy veins lie approximately parallel to the bedding of the Frichard formation, which in the mine workings is a dark gray to nearly black thin-bedded argillite. The lenses of quartz that form the vein do not lie at one horizon in the argillite, but are arranged en echelon so that one lens is succeeded on the strike by another, either in the foot wall or hanging wall. Locally the beds and enclosed veins form folds, and hence their attitudes vary considerably from place to place. On the Whistler tunnel the average strike is nearly north, whereas on the Occident level it is northeast. Dips range from about 15° to 25° W.

The vein material is principally white quartz, either massive or layered, with variable amounts of altered wall rock, ankerite, sericite, albite, chlorite, rutile, sulphides, and gold. The layered quartz is not persistent, but is succeeded on the strike by massive quartz. In general, layers of white quartz are separated by thin black layers that do not lie exactly parallel to the walls of the veins, but cross the quartz at small angles. The black layers are composed largely of sulphides, with variable amounts of fine-grained quartz, sericite, and ankerite. The gangue and ore minerals in the Mother Lode have been introduced in about the same sequence as in the other mines of the district. Albite (Ang) appears to have been formed first. It was followed by relatively coarse-grained quartz in which the length of the grains ranges from about 0.5 to 1.6 millimeters and averages about 0.6 millimeter. Both albite and quartz were fractured, and ankerite (w = 1.70) was deposited in and along the fractures. Further fracturing followed, and quartz with grains from 0.01 to 0.1 millimeter across was deposited. This fine-grained quartz was followed by sericite and probably rutile, although this relation is not definitely established. Sulphides were introduced after the sericite, either pyrite or arsenopyrite first, then followed in order by sphalerite, chalcopyrite, and galena in an overlapping sequence. Gold was deposited later than the sulphides, for it fills fractures in all of them, although in many places it lies in fractures that cut quartz. More fine-grained quartz in tiny veinlets was introduced after the gold, and it in turn appears to have been followed by a mineral of the chlorite group, although this relationship is not well established.

The Gold Back vein (pp. 43-44) is well exposed on the Whistler, Slab, Arrastre, and Occident levels, where it occupies a shear zone over 100 feet wide. In the Mother Lode mine it generally strikes N. 20° W. and dips about vertically. It is

out by a number of gouge seams, which in places aggregate several feet in thickness. In general, the gouge seams are parallel to the trend of the shearing in the Gold Back vein. About 260 feet from the portal on the Arrastre level white quartz along bedding cuts the bluish-gray quartz of the Gold Back. The same relation can be seen on the Occident level about 230 feet from the portal. On the other hand, the bedded veins are clearly offset along the bands of gouge in the Gold Back; for example, it appears that the vein as exposed in the Arrastre tunnel is a faulted segment of the vein mined above the Slab tunnel (pl. 3). If this is true, the bedding vein has been offset about 95 feet vertically. The same relations are shown on a smaller scale about 250 feet from the portal of the Arrastre tunnel, where the small bedding veins of white quartz cut the bluish-gray quartz of the Gold Back, for here also the bedding veins are cut and offset along small seams of gouge (fig. 15).

The gold of the bedding veins is sporadically distributed. Some ore contains 30 to 40 ounces of gold to the ton and some contains only traces. The better ore appears to occur in bunches or shoots. In general, however, the layered ore shows the higher average grade, although some of the richest pockets have been found in massive white quartz. According to Ransome, the average toner of this ore treated in 1931 was about 1.5 ounces to the ton, and one lot of 30 tons of Mother Lode ore mined in 1890 averaged 4.6 ounces to the ton. In 1935, about 10 tons of ore mined from the small stope 370 feet from the portal of the Arrastre tunnel were shipped by Ross Roundy to the Bunker Hill & Sullivan Mining & Concentrating Company's smelter. According to the smelter returns, this ore averaged 2.651 ounces of gold and 1.87 ounces of silver to the ton. It also contained 2.8 per cent iron, 1.4 per cent sulphur, 0.79 per cent arsenic, 88.6 per cent insoluble matter, and a trace of antimony. The shoot from which this ore was mined may be the extension of the shoot mined above the Whistler tunnel, for the stope as outlined appears to trend toward it (pl. 3).

The average gold content of the Gold Back vein in the Mother Lode mine is not known, but the range appears to be from a trace to nearly an ounce to the ton. Mr. E. B. Gibbs, of the Idaho Mother Lode Gold Mines, Inc., reports assays that ranged from 0.11 to 0.84 ounce of gold to the ton. He reports that 37 samples from the Whistler, Slab, and Arrastre tunnels assayed from 0.3 to 1.62 per cent lead and from 1.40 to 2.07 per cent zinc. According to Mr. Gibbs, these samples were taken across widths ranging from 28 to 42 feet and hence do not show the range of the lead and zinc content for the lenses and irregular bodies of high-grade ore.

FOUR SQUARE MINE

Location and development

The Four Square property is located about 2 miles west of Murray and consists of 24 claims that were formerly included in the Golden Winnie, Crown Point, and Flagstaff groups. The Crown Point and Flagstaff are about 1 mile southeast of the Four Square workings and hence are described separately.

The Four Square mill, camp, and underground workings are on the south side of Pritchard Creek. In 1935, most of the underground workings were on three levels: the Achievement, Main crosscut, and Intermediate levels. The mouth of the Main crosscut is about 60 feet vertically higher than the camp, and in 1935 was about 1,000 feet long (pl. 4). At 250 feet it cut the No. 1 vein, and from it a drift was turned that followed the vein westward about 40 feet. At 600 feet from the portal the crosscut intersected the No. 2 vein, and drifts 440 and 410 feet long.

Fig. 16. Sketch showing relationship between bed vein and Gold Back lode, 250 feet from portal of Arrastic tunnel of Mother Lode mine.

Fig. 15. Sketch showing banding in bedding vein on No. 2 drift east of Main Crosscut level about 15 feet east of crosscut to Achievement winze. Four square mine.
were driven along the vein to the east and west respectively. At 880 feet from the portal the Main crosscut intersected the No. 3 vein, and drifts were run 80 feet eastward and 70 feet westward. The Achievement tunnel lies 40 feet lower than the Main crosscut level and is driven from the surface westward along the No. 2 vein for 650 feet. In 1935, about 120 feet of this level were closed by caved. The Intermediate level is about 175 feet vertically higher than the Main crosscut level and is connected with it by a two-compartment inclined raise. On the Intermediate level a crosscut 340 feet long runs from the surface to the No. 2 vein. At 190 feet from the portal the crosscut branches, and at 150 feet farther the branch also cuts the vein. On the Intermediate level there are about 400 feet of drifts east and 390 feet west on the No. 2 vein.

Since 1936 a winze was sunk 465 feet at 45° below the bottom of the raise connecting the Intermediate and Main crosscut levels. From 200 to 300 feet the winze followed the vein, but below the 300-foot level it was in the footwall. At 465 feet the winze again entered the vein. Only a short drift was run on the vein on the 200-foot level, and no drifting was done below this level. It is not shown on plate 4.

History and production

Most of the veins at the Four Square mine were located by E. W. Smith in 1884, the year following the discovery of placer gold near Murray. In November, 1931, the property was acquired by the Four Square Gold Company, which began development work in September, 1932.

According to Mr. Hall, the production up to 1931 was between $170,000 and $200,000, and came largely from the Achievement level on the No. 2 vein. This ore was treated in an arrastre and in a 10-stamp mill. In 1891, $5,600 was recovered at the old Wallace Sampler from 27 sacks of ore mined from the Smith tunnel. During 1914-15, several tons of scheelite concentrates were produced. From February 18 to November 19, 1934, 7,340 tons of ore treated in the Four Square mill yielded 1,129.71 ounces of gold. Therefore, on the basis of the above figures, the total production up to November 19, 1934, appears to have been between $225,000 and $250,000.

Geology

Three veins, known as Nos. 1, 2, and 3, are exposed in the Four Square workings. No. 1 has been developed for about 70 feet, No. 2 for about 800 feet, and No. 3 for about 100 feet. No. 1 vein strikes about N. 80° W. and dips 55° N. The strike of No. 2 vein ranges from N. 65° W. near the face of the west drift, to N. 80° W. in the east drift, and it dips about 40° to 60° N. but averages about 50° N.

Where exposed on the Main crosscut level the No. 1 vein is from 2 to 5 inches wide. The width of the No. 2 vein ranges from less than an inch to about 4 feet, but throughout it probably averages about 12 to 14 inches. On the Main crosscut level the No. 3 vein is from one-half to 2 inches wide.

The veins approximately follow the bedding of the thinly laminated, nearly black argillite of the Prichard formation. The thin-bedded argillites in which Nos. 1 and 3 veins occur are 12 and 5 feet thick respectively, and both are underlain and overlain by massive or faintly layered nearly black argillaceous quartzite. The No. 2 vein is near the base of a zone of thin-bedded, black argillite about 110 feet thick, near the middle of which there is a bed of massive white

1/ Hall, Julius F., personal communication.
2/ Hall, Julius F., from private report.
quartzite about 5 feet thick. The thin-beded argillite is overlain by massive and faintly layered, nearly black argillaceous quartzite, but is underlain by massive white quartzite. About 5 feet below the top of this white quartzite, which is about 40 feet thick, there is a 7-foot bed of moderately well banded nearly black quartzite. This quartzite is underlain by moderately well banded nearly black argillaceous quartzite, probably about 50 feet thick. This, in turn, is underlain by about 25 feet of massive white quartzite followed by 7 feet of thin-beded nearly black argillite containing two small quartz veins, each about 1 inch thick. This thin-beded argillite is underlain by about 100 feet of nearly black massive and faintly banded argillaceous quartzite, which extends to the face of the main crosscut. This quartzite includes the 5-foot band of thin-beded argillite that encloses the No. 3 vein.

The veins are generally separated from their walls by dark-gray gouge. They are not single tabular bodies throughout, but in many places consist of two or more nearly parallel branches (pl. 4). The vein material is white quartz, which nearly everywhere shows numerous thin dark layers that are approximately parallel to the walls of the veins. In places, angular blocks of wall rock are included in the quartz. The dark layers are composed largely of finely disseminated sulphides, fine-grained quartz, ankerite, and sericite. The dark layers are not exactly parallel to the sides of the veins, but, as shown in Figure 16, cut the quartz at small angles. Where the quartz does not contain sulphides, it is massive and white, but a sharp line cannot be drawn between the massive and the layered quartz.

All the veins are cut by many closely spaced faults, most of which strike east of north and dip at angles that range from 30° to 70° WNW. Most of the faults displace the veins from 1 to 20 feet, or, more rarely, 50 feet.

The hypogene (primary) ore minerals include arsenopyrite, pyrite, sphalerite, galena, chalcopyrite, scheelite, and gold. Selenium has been found in the concentrates and tellurides have been reported, but none was seen in polished sections of the ores. Arsenopyrite is the most abundant sulphide, and, even though quartz is the most abundant gangue mineral, some ankerite, sericite, and chlorite are usually present. The ore and gangue minerals have been introduced in a fairly definite sequence separated by periods of fracturing. Coarse-grained quartz with grains from 0.8 to nearly 3 millimeters across was introduced first. It was broken by nearly parallel fractures and very fine-grained quartz with grains from 0.006 to 0.1 millimeter across was introduced into the fractures. Ankerite was then deposited along new and reopened fractures, and after it sericite and sulphides were deposited. Fracturing succeeded the sulphides, and more fine-grained quartz, gold, and chlorite were introduced. The sulphides were deposited as an overlapping sequence - arsenopyrite and pyrite first, followed in turn by sphalerite, galena, and chalcopyrite, although the latter occurs principally as blebs in sphalerite. Gold is found mostly in fractures in quartz, but also cuts arsenopyrite and other sulphides, and appears to be closely related in age to the third generation of quartz and chlorite. The relation of scheelite to the other minerals was not determined in the ores from the Four Square, but in other nearby mines it is one of the earliest vein minerals, preceded only by albite and the first generation of quartz.

The wall-rocks show alteration for some distance from the veins, but at no place, even next to the veins, is it great. The process of alteration largely involved introduction of quartz, sericite, ankerite, and pyrite, but tourmaline and epidote also were seen. Tiny elongated prisms of tourmaline appear to have been introduced during this process of alteration, although this relation was not proved. Gold was not seen in the wall-rocks, but it is reported that in some places enough occurs next to the vein quartz to make low-grade ore.

Hal, Julius P., personal communication.
The ore at the Four Square is valuable chiefly for its contents of gold and tungsten. According to Mr. Hall 1, the mill feed in 1934 contained 0.17 ounce gold to the ton from which 0.1625 ounce was recovered in the mill. Assays indicate that much waste rock was mixed with the quartz during mining. According to Mr. Hall, the ore on the Main crosscut level contains about 0.4 per cent WO3 and the Intermediate level about 0.1 per cent.

**KING MINE**

The King property lies north of Frichard Creek, about opposite the Four Square mine. Several short crosscuts, some small stopes, and a shaft, possibly aggregating about 1,000 feet, have been opened on two veins known as the Skookum and Small Hopes. Also, there is a drift about 100 feet long, known as the Grouse tunnel, that is believed to explore the shear zone that contains the Crown Point vein, described below. Most of the workings are now inaccessible.

Little was learned about the history of the King property, but the veins are known to have been located at about the same time as those on the Four Square property. A 10-stamp mill in Accident Gulch was operated for several years, and the old stamps are still standing. The property is owned by the William W. Drummond estate of Kentucky. Adam Aulbach, who bought most of the gold from the King property, has estimated that it yielded about $200,000 2 worth of gold.

The two principal veins on the King property are poorly exposed, owing to caved workings and to the fact that much of the vein near the surface has been mined. As shown by open stopes, the Skookum and Small Hopes veins strike from N. 75° W. to east and west, and dip from 46° to 56° N.W. (fig. 17). The Small Hopes vein is overlain by about 15 feet of thin-beded argillite, which in turn is overlain by nearly black massive argillaceous quartzite with poorly defined layering. Underneath the vein there is about 200 feet of faintly layered nearly black massive argillaceous quartzite. Below this lies 70 feet of thin-beded argillite that encloses the Skookum vein, about 15 feet above the base. Below the thin-beded argillite lies 38 feet of massive white quartzite, which is underlain by 30 feet of faintly layered, nearly black, massive argillaceous quartzite. Below this quartzite there is a 6-foot band of massive white quartzite, and below this band above the road there lies another 6 feet of massive white quartzite, but there are no outcrops below the road.

Like the Four Square veins, the Skookum and Small Hopes veins approximately follow the bedding in thinly laminated argillite, and only rarely form single tabular bodies, although in places they branch into two or more nearly parallel veins. For example, in the open stope near the portal to the Skookum No. 2 tunnel, a sheared zone 3 or 4 feet wide in thin-beded argillite contains several small quartz stringers from 2 to 3 inches thick. Also, like those in the Four Square mine, most of the veins contain numerous tiny nearly parallel fractures filled with sulphides, fine-grained quartz, and sericite that give the vein a distinctly banded appearance.

Both the Skookum and Small Hopes veins are cut by many cross faults, the offsets of which range from a few feet to over 200 feet. The offsets are well shown on the hillside along the Skookum vein, but the smaller displacements could not be recognized along the Small Hopes vein because of poor exposures, especially where the material from the overlying high gravel covered the hillside.

No reliable information on the grade of the ore from the Skookum and Small Hopes veins is available. Much of the ore was mined near the surface, and hence may have had the benefit of secondary enrichment.

1/ Hall, Julius F., private report.
2/ Hall, Julius F., personal communication.
Fig. 17. Map showing relationships between Small Hopes, Skookum, and Four Square veins.
The Grouse tunnel is driven on a wide shear zone. The sheared rock was somewhat silicified, but as now exposed no quartz can be seen in place. However, some shattered quartz with considerable limonite is scattered over the dump.

RELATIONSHIP BETWEEN THE FOUR SQUARE AND KING VEINS

It is generally believed that the Small Hopes and Skookum veins of the King are faulted segments of the Nos. 1 and 2 veins of the Four Square. The fault that is shown offsetting the Small Hopes vein in figure 17 has a horizontal displacement of about 200 feet. An additional offset of about 70 feet in the same direction would bring the Skookum vein of the King mine into juxtaposition with the No. 2 vein of the Four Square mine. If it exists, this fault cannot be seen because of overburden, but it will be present below Frichard Creek.

As measured up the hillsides the stratigraphic distance between the Skookum and Small Hopes veins is 240 feet, whereas the stratigraphic distance between the Nos. 1 and 2 veins of the Four Square mine, as measured on the Main crosscut level, is 270 feet. The difference of 30 feet is a reasonable difference when the possible errors inherent in slope measurements and the possible changes in dip are considered. Furthermore, considerable uncertainty is involved in any stratigraphic measurement near the Four Square mine, because numerous small faults offset the beds.

The stratigraphic sequence between and adjacent to the Skookum and Small Hopes veins and between the Nos. 1 and 2 veins of the Four Square mine is similar. The Small Hopes vein is at the top of a 10-foot bed of thinly laminated nearly black argillite, whereas the No. 1 vein of the Four Square is near the bottom of a 12-foot bed. The contact between well-laminated argillite and faintly laminated argillaceous quartzite is gradational, and hence the limits may differ from place to place. The 5-foot layer of white quartzite, which lies 50 feet above the No. 2 vein of the Four Square mine, was not seen on the hillsides at the King, but such a bed could be overlooked on the surface where exposures are not complete. The white quartzite beds beneath the No. 2 and Skookum veins should be the best markers for correlation, but unfortunately the exposures near the King vein are not complete. In general, so far as exposed, the sequences as recorded are similar, but not exactly alike. Also, at the west end of the Achievement tunnel the No. 2 vein is about 10 feet above the white quartzite that elsewhere forms the footwall of the vein, whereas the Skookum vein is about 19 feet above it. However, in spite of the small apparent discrepancies discussed above, the evidence seems to indicate that the Small Hopes vein is a faulted segment of the No. 1 vein of the Four Square mine and that the Skookum vein is the faulted segment of the No. 2 vein.

MOUNTAIN LION GROUP

The Mountain Lion group lies about a mile west of Murray, on the south side of Frichard Creek. The property is owned by William Wylie and is developed largely through three tunnels known as the No. 1 (Mill), No. 2 (Rock), and No. 3 tunnels (fig. 18). The No. 1 tunnel is a crosscut 160 feet long that runs to the north vein. From it one drift was run 90 feet eastward along the vein and another more than 170 feet westward. Above the No. 1 level are stopes that probably connect with the two levels above. The No. 2 tunnel is 580 feet long and from it several short drifts have been driven. The drift 80 feet from the portal is connected by stopes with the No. 3 level. No. 3 tunnel is a crosscut that reaches the north vein at 50 feet. Above it are filled stopes.

The Mountain Lion group was located as the Golden Circle by Silas Brown in 1884. Wylie, William, personal communication.

Wylie, William, personal communication.
MAP OF MOUNTAIN LION MINE
MURRAY, IDAHO JULY 1935

LEGEND
- Quartz
- Gouge
- Caves and filling
- Inclined workings
- Raise

Fig. 18. Map of Mountain Lion mine
Mountain Lion. Thereafter Mr. Wylie operated the property for many years, but in 1936 it was being operated under option by the Kings Pass Gold Syndicate. The total production is not known, but Mr. Wylie states that he mined $70,000 worth of ore from the stope above the No. 1 level, which was treated in a small 3-stamp mill near the mouth of the No. 1 tunnel.

Two veins are exposed in the workings of the Mountain Lion mine, but all of the production has come from the north vein. This vein is in thin-bedded argillite above a footwall of dark quartzite. The vein curves slightly, but in general strikes eastward and dips about 25° N. It ranges in width from a few inches to more than 3 feet.

The ore now showing in the north vein is soft, reddish-brown, clay-like material that is sticky and very wet. In places angular fragments of quartz can be seen in the clay-like material. In a few places layered quartz can be seen following the bedding of the argillite. According to Mr. Wylie, the best ore in the stope above the No. 1 tunnel was solid quartz, which in places was 3 feet wide. The layered quartz is much like that at the Four Square mine. The ore minerals include arsenopyrite, pyrite, galena, sphalerite, chalcopyrite, scheelite, and gold. The gold occurs in quartz and cuts sulphides and is found in the clay-like material along the vein. High-grade pockets and shoots occurred along the vein and when washed a panfull yielded 5.6 ounces. According to Mr. Wylie, the ore from the stope above the No. 1 level contained 1 ounce of gold to the mine car (1,200 pounds).

This agrees closely with the production record of the Bureau of Mines, which shows that the gold recovered between 1914 and 1933 ranged by years from 0.625 to 3.207 ounces to the ton and averaged 1.554 ounces. The recovery of gold from ores by the amalgamation process in the Murray district is reported to be about 60 per cent, so that on this basis the ore as mined from the north vein must have carried nearly 2.6 ounces of gold to the ton.

The south vein lies along a narrow shear zone approximately parallel to the bedding in moderately well-layered argillaceous quartzite (fig. 16). Next to the vein many small stringers of quartz cut the bedding. The width of the quartz ranges from less than an inch to 3 inches or more. The thick gouge and crushed rock that is found along the north vein is absent here. The gold content of the south vein is not known to the writer.

The north vein of the Mountain Lion group differs from those of other nearby properties because of the large amount of gouge and crushed rock along it. The fragments of vein quartz and wall-rock scattered through the clay-like material show that the movement responsible for the formation of the gouge was subsequent to the deposition of the quartz, but the nature and origin of the movement is not clear. However, the north vein is very near the surface, and the dip is about the same as the slope of the hill. Both the topography and the character of the overburden indicate that some landsliding has occurred near the mine. For example, in the open cut near the No. 3 tunnel the overburden is from 50 to 70 feet thick and is composed mostly of soil and rock fragments, but in places there are very large blocks of rock that appear to have originated as landslide material. From this evidence, it seems likely that the crushing along the north vein resulted from shallow landslide movements and that the crushing effects will only be found close to the surface.

BUCKEYE BOY MINE

The Buckeye Boy mine in Dream Gulch, about a mile from its mouth, was one of the early locations in the Murray district. Several relatively short tunnels developed it, and two were open in 1932.

//Wylie, William, personal communication.

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The Buckeye Boy mine appears to have been worked first in 1885 and thereafter for many years by Adam Aulbach. It is now owned by Mrs. David Sellers of Murray, but in 1955 it was being operated by Sigmund Thorckelson.

Like most of the other gold deposits of the Murray district, the Buckeye Boy vein lies approximately along the bedding of thinly laminated argillite of the Prichard formation. In the No. 3 (lower) tunnel, which was being cleaned out in 1955, the strike of the argillite was N. 20° to 30° E., and the dip was about 15° N.W. A few feet above this level, ore was mined from a flat stope. Several faults are found on the No. 3 level; one, 245 feet from the portal, which strikes N. 40° W. and dips 65° S.W., is marked by 6 inches of dark gray gouge. In the upper tunnel, about 240 feet vertically above No. 3, another flat stope was mined, and about 6 inches of layered quartz is still exposed in one end of the stope. It strikes N. 20° E. and dips about 50° N. This vein appears to be terminated on the north by a steeply dipping east-west fault.

Most of the production of the Buckeye Boy came from the Frank Reed stope. The ore from this stope was treated in a small 2-stamp mill and yielded on the plates $35 a ton. According to Ransome and Calkins, very rich pockets also occurred at the Buckeye Boy mine.

DEW DROP MINE

The Dew Drop mine lies about one-fourth mile above the mouth of Wesp Gulch. The road to the Pontiac mine passes within about 300 feet of the workings. Nearly all the mining has been done in two tunnels on opposite sides of Wesp Gulch. All of the production of about $30,000 was derived in the early days from the tunnel on the east side of the gulch. This tunnel is about 125 feet long, but the production came from a flat stope about 60 feet from the portal. The tunnel on the west side of the gulch extends into the hill for 300 feet.

The ore in the east tunnel came from a small but rich bedding vein in argillite of the Prichard formation. The vein strikes N. 30° E. and dips 120° NW. Near the edges of the stope the quartz is massive and white, and contains many inclusions of argillite. No ore was seen in the west tunnel, but several faults are exposed in it. At 180 feet from the portal, a wide fault zone strikes N. 50° W. and dips 30° to 40° S.W. East of the fault the beds are considerably folded, whereas west of it they are nearly flat.

WAKEUP JIM MINE

The Wakeup Jim mine is near the head of Trail Creek and by air line about 1-1/2 miles southwest of Murray. By road, it is 2 miles east of Kings Pass. The property is developed by four principal levels, Nos. 1, 2, 4, and 5 (pl. 5). The lower level (No. 1) is a crosscut about 600 feet long, from which three short drifts have been driven. No. 2 level is 110 feet above No. 1 and is connected with it by a raise, now inaccessible. No. 2 level is a drift about 200 feet long, but only about 180 feet are accessible. Two crosscuts, one 140 feet and the other 80 feet, have been turned from this drift. The No. 3 level is a short drift only 50 feet long, Nos. 4 and 5 levels are drifts, each about 140 feet long. No. 4 is 168 feet above No. 1, and No. 5 is 200 feet above No. 1. An incline about 80 feet long has been driven at the end of the No. 5 level. Small stopes have been opened on No. 2 and No. 4 levels.

2/ Wylyis, William, personal communication.
4/ Stapleton, H. C., personal communication.
The Wakeup Jim mine was located as the Union in the early nineties by Sam Starr, Tom Schuster, and the Ward brothers, Sam, Blair, and Jim 1/. Since then, it has been relocated a number of times, but in 1935 it was owned by Frank L. Smith and Charles Bank. In 1934-35, Mr. C. J. Van Curen shipped about 40 tons of ore 2/. The total production is not known, but Mr. Wylie states that, in addition to the ore shipped by Mr. Van Curen, $15,000 in rich ore was taken out of one pocket shortly after discovery.

The ore at the Wakeup Jim occurs, for the most part, along a flat-dipping, overthrust fault cutting laminated argillite of the P Richard formation. The ore consists of white quartz with or without layers of sulphides. The vein strikes a little east of north and dips, in general, to the east, although the fault along which it occurs has a rolling surface. Almost everywhere the bedding in the footwall stands at steep angles, whereas that in the hanging wall is relatively flat. A large steeply dipping fault, probably post-mineral, is followed by the west drift on the No. 1 level and is cut by the east drift of the No. 2 level. This fault strikes approximately north. On the No. 1 level the fault is marked by 6 feet of nearly solid gouge, but in the crosscut on the No. 2 level it consists of several well-defined branches that occupy a zone about 20 feet wide. According to Mr. Van Curen 3/, the fault terminated the vein in the part of the stope now inaccessible at the end of the No. 2 level.

The minerals in the ore are similar to those of the other gold-quartz veins of the Murray district. Arsenopyrite and pyrite are the most abundant sulphides, although some galena, sphalerite, and chalcopyrite are disseminated through the quartz. At no place do the sulphides make up much more than 5 per cent of the ore. A shipment of 18 tons sent to a smelter in September, 1934, contained 2,089 ounces of gold and 1,533 ounces of silver to the ton. Another lot of 21,455 tons shipped in June, 1935, contained 1,168 ounces of gold and 1,7 ounces of silver to the ton. According to Mr. Van Curen, the best ore, which contains considerable sulphides, occurs in shoots.

PILOT MINE

The Pilot mine lies about half a mile above the mouth of Gold Run Gulch. The principal working is a tunnel about 700 feet long. Little is known about the property, although, according to Mr. Wylie 4/, some exceedingly rich ore was mined in the early days. The Bureau of Mines records for 1928 a production of 1 ton of ore which yielded 15.46 ounces of gold and 19 ounces of silver.

The Pilot tunnel follows a shear zone in the P Richard formation for about 400 feet. The shear zone trends N. 25° W. and dips about 70° N.E. At 400 feet from the portal there is a small stope about 70 feet long from which a bedding quartz vein was mined. Both beds and vein are folded so that the stope, which starts on a steep dip, flattens as it goes upward. Beyond the stope the tunnel follows a shear zone for about 280 feet. At the breast of the tunnel, the zone, which is about 4 feet wide, strikes N. 45° W. and dips 70° N.E., whereas the strike of the bedding is N. 15° W. and the dip 17° N.E. Some quartz, generally only 1 or 2 inches wide, follows the shearing.

GOLD COIN GROUP

The Gold Coin group includes five lode and two placer claims 5/. Two of the lode claims were formerly owned by Francis Jenkins, who mined and treated considerable ore in a mill in Duncan Gulch. The other three of the lode claims comprised

1/ Historical data by William Wylie.
2/ Van Curen, C. J., personal communication.
3/ Ibid.
4/ Wylie, William, personal communication.
5/ Olsson, Otto A., personal communication.

39.
the Fannie group of Blaine and San Ward. The workings of the Jenkins claims are no longer accessible, but, as indicated by the size of the dumps, considerable underground work was done. The Gold Coin workings of the Fannie group are open and are described below.

The Gold Coin workings of the Fannie group are about half a mile up Trail Creek from the old town of Thaird. The workings are about 350 feet above the creek but are connected with it by an old tram, now in disrepair. Most all the underground work has been done on one level, 470 feet long, from which a raise has been run to the surface (pl. 6). Another tunnel 16 feet lower than this follows the vein for 40 feet. The total production from the Gold Coin workings is not known to the writer, but, from the size of the stopes, it is not large. In 1934, C. J. Van Curen shipped 12 tons of sorted ore from which $30 a ton was recovered. In 1935, the Gold Coin group was under option to the Hypotheek Mining & Milling Co.

The ore is layered quartz that lies approximately along the bedding of dark gray argillite of the Prichard formation. Both beds and vein are folded, and in general they strike northeast and dip 17° to 20° N.W. The quartz occurs along the bedding in lens-like bodies separated by dark gray gouge, which in places contains pieces of drag quartz. As exposed, the lenses are from a few feet to more than 100 feet long. The thickness of the quartz ranges from a few inches to 3 feet, but probably averages 15 inches.

The ore minerals occur mostly along thin, nearly parallel layers in the quartz. Arsenopyrite is the most abundant ore mineral, but pyrite, sphalerite, galena, chalcopyrite, and gold accompany it. The sulphides are oxidized at the surface, but 30 feet from the portal of the tunnel they are practically unaltered.

As shown by assays, the better ore appears to form shoots in the quartz, apparently near the axes of folds. Assays by Mr. Van Curen indicate that the quartz contains from about 0.1 to 1.75 ounces of gold to the ton.

CROWN POINT AND FLAGSTAFF MINES

The Crown Point and Flagstaff claims are about 2 miles west of Murray, on the south side of Prichard Creek. Only a few short tunnels have been run on these claims.

The Crown Point claim was located by Robert J. Linden, Francis Jenkins, and Adam Aulbach. The Flagstaff, which joins the Crown Point on the north, was located by Charles W. O'Neill. In 1934, both claims were acquired by the Four Square mine.

The Crown Point and Flagstaff claims cover the extension of the Crown Point vein, which can be traced by intermittent exposures from Duncan Gulch to Prichard Creek (pl. 1). North of Prichard Creek the vein appears to project to the sheared zone on which the Grouse tunnel of the King property is run, although at that place there is not much quartz. The vein strikes about N. 150° to 40° E., and dips about 70° S.E. to vertically. In most places, the dips are nearly vertical.

The vein is a wide shear zone into which variable amounts of white quartz containing some sulphides were introduced. Near the vein the beds are considerably folded and sheared. As exposed along the road about 1-1/2 miles east of Kings Pass, the vein contains about 15 feet of nearly solid white quartz and about the same width of mixed quartz and silicified wall-rock. Here the quartz contains numerous patches of iron oxide. In Duncan Gulch, the Crown Point vein crops out

1/ Van Curen, C. J., personal communication.
boldly about 10 feet above the surface. Here the vein is composed of a mixture of white quartz and silicified argillite of the Prihard formation. Quartz makes up about half the vein. In places, there are irregular bodies of iron oxides, probably oxidation products of pyrite or other sulphides. The structure in the vein at this place strikes N. 25° E. and dips 80° S.E.

The gold content of the Crown Point vein is not known. The vein, however, lies along a strong shear zone, and the quartz appears to be persistent, although it cannot be followed continuously for more than 800 or 1,000 feet because of dense timber and thick soil.

TIGER MINE

The Tiger group of claims is in Tiger Gulch, about a mile southwest of Murray. The property is reached by a trail which rises 700 feet in altitude in a horizontal distance of one-fourth mile. The development work consists of a 400-foot crosscut, from which short drifts have been driven in both directions, and several short workings on the ridge top about 200 feet vertically above the crosscut level. Most of the work at the Tiger was done by Adam Aulbach. It is now owned by his daughter, Mrs. David Sellers of Murray. So far as known, there has been no production.

The deposit at the Tiger consists of a shear zone striking N. 10° E. and dipping 80° N.W., which was intensely silicified across a width of 5 or 6 feet. The shear zone crosses a dense fine-grained, highly altered, lamprophyre dike, in which much quartz, ankerite, disseminated pyrite, and a little sericite and galena have been deposited. The lath-shaped plagioclase crystals that remain have a composition of An25, whereas biotite is entirely altered to chlorite. Veinlets that cut the rock contain quartz, ankerite, sericite, and sulphides. The bedding in the argillite close to the sheared zone is nearly flat.

LEAD AND ZINC MINES AND PROSPECTS

PONTIAC (TERRIBLE EDITH) MINE

The Pontiac mine is located near the head of Weep Gulch, 2-1/2 miles by road from the mouth of the gulch. The road, which follows a circuitous route up the ridge between Weep and Cougar gulches, rises over 1,000 feet between the county road at Prihard Creek and the lower tunnel of the Pontiac. The Pontiac is developed through three principal levels - Nos. 2, 3, and 4. Between levels 3 and 4 there are two intermediate levels 200 and 300 feet, respectively, above level 4. Level 3 is about 500 feet above level 4 and level 2 about 670 feet above level 4. Several stopes, two with lengths of over 100 feet, have been opened from level 4. One, with a stope length of about 80 feet, has been opened from level 3. There are more than 2,000 feet of drifts and crosscuts on level 4, more than 600 feet on level 3, more than 400 feet on level 2, and more than 500 feet on each of the two intermediate levels. A two-compartment inclined raise connects level 4 with the intermediate levels (fig. 19).

The Terrible group was located by James Woods and the Edith by Wash Snyder about 1886. These claims were consolidated as the Terrible Edith and were so known until 1925, when the property was acquired by the Chester Mining Company. The Chester Company was later reorganized as the Pontiac Mining Company. The total production is not known, but, according to estimates made by Mr. Stapleton, it is about $200,000. The following production figures are from records compiled by V. C. Heikes and C. N. Gerry for the U. S. Geological Survey until 1925, and for the U.S. Bureau of Mines since 1925.
Fig. 19. Map of Pontiac mine
Reported production of Pontiac mine, Murray, Idaho, 1904-1935
(Published by permission of H. C. Stapleton)

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<thead>
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<th>Year</th>
<th>Gold</th>
<th>Silver</th>
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<td>1921</td>
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Totals: 2,715,1,758,902,962,316,572,15.87,7,399

*No production reported for 1905 to 1910, 1914, 1917 to 1920, 1922 to 1925, and 1931 to 1932.

At the Pontiac mine the ore lies along shear zones in dark gray banded argillite of the Frichard formation. In general, the shear zones strike N. 15° to 20° W. and dip 40° to 60° S.W., whereas the bedding of the enclosing rocks in general strikes N. 20° to 30° E. and dips about 30° to 45° N.W. The ore minerals included abundant quartz with variable amounts of pyrite, galena, sphalerite, and chalcopyrite; only a little chalcopyrite is present. In some places, the ore does not contain much quartz, but is of wall-rock partly replaced by sulphides. The ore occurs as shoots in the shear zone that range from a few feet to more than 100 feet in length, and from a few inches to several feet in thickness. In places, the shoots are composed almost entirely of sulphides.

As reported to the U. S. Bureau of Mines, the ore contained from 13 to 76 per cent lead, from 5 to 36 per cent zinc, and from 1 to 5 ounces of silver to the ton. It averaged 54 per cent lead, 18 per cent zinc, and 2.7 ounces of silver to the ton. The gold content as reported ranged from 0.0004 to 0.008 ounce to the ton, but Mr. Stapleton states that some of the ore contains from $3 to $10 to a ton in gold.

ANCHOR MINES

The Anchor mine is about 1 mile above the mouth of Alder Gulch. It was first located by Dan Daugherty as the Golden Reward, but is now owned by John Murphy, Mike Melley, and H. L. Day. Most of the work has been done on two tunnels. The lower one, the longest, was closed in 1935. The upper tunnel, which is about 190 feet above the lower, has more than 800 feet of workings, including both drifts and crosscuts.

Four nearly parallel shear zones are exposed in the upper tunnel that cuts the Frichard formation, which here contains a number of white quartzite beds. The
shear zones strike N. 60° to 86° W., and dip from 70° W. to vertically. One shear zone has been followed for 300 feet. In it there are irregular bodies of high-grade galena ore, but work on the upper level has not yet developed any large shoot. A dense, dark colored lamprophyre dike, 18 feet wide, is exposed in the upper tunnel about 160 feet from the portal. It strikes N. 45° E., almost at right angles to the mineralized shear zones, and is nearly vertical.

GOLD BACK AND GRAY EAGLE MINES

The deposits at the Gold Back and Gray Eagle mines, although 2 miles apart, are essentially similar and presumably on the same lode.

The Gold Back claims are situated between Wasp and Gold Run gulches, immediately east of Murray, whereas the Gray Eagle group is in Oregon Gulch. The Gold Back group, consisting of four claims, is owned by John Murphy, N. E. Lafon, and B. Brookhuris. The Gray Eagle was recorded in 1924 by Walter Hansen and C. J., Walter A., Arthur, and Fred C. Johnson.

The principal opening on the Gold Back claims is a crosscut 400 feet long, which starts on the north side of Prichard Creek just below the county road. From the crosscut, drifts have been driven 400 feet northwest and 25 feet southeast along the Gold Back lode. Shorter tunnels have been driven on the lode in Cougar Gulch, but only one is now accessible. The lowest tunnel of the Gray Eagle is a crosscut 700 feet long from which drifts have been driven about 400 feet northwest and about the same distance southeast along the lode. Several other shorter tunnels expose the lode at higher altitudes.

The lode explored at the Gold Back and Gray Eagle is one of the most extensively mineralized shear zones in the Murray district and is known as the Gold Back lode. It appears to lie along the Murray Peak fault. The lode crops out in Oregon Gulch, in Gold Run and Cougar gulches, at the Mother Lode mine, and in Ophir Gulch. Because of dense timber and deep soil, it cannot be followed continuously, but it can be traced much of the distance from Ophir Gulch to Alder Gulch by outcrops, underground exposures, and surface pits. Between Alder Gulch and the ridge south of Oregon Gulch, it is entirely masked by timber and soil. The strike of the Gold Back lode ranges from nearly northwest near Ophir Gulch to nearly north in Oregon Gulch. The dip is nearly everywhere almost vertical.

For the most part, the Gold Back lode lies in the Prichard formation that was intensely silicified and replaced by variable amounts of sulphide minerals. In places, the shear zone is several hundred feet wide, but the silicified areas are generally less than 100 feet wide, and the intensely silicified part is less than 25 feet. Some sulphides occur all along the lode, but they are more abundant in some places than in others. On the Gold Back group in Cougar Gulch, for example, only about a foot near the center of the lode contains abundant sulphides, whereas at the Gray Eagle sulphides are abundant across 7 feet.

The ore minerals include pyrrhotite, pyrite, sphalerite, galena, chalcopyrite, and arsenopyrite. The gangue is principally quartz and altered wall-rock, but ankerite and sericite are nearly everywhere present and in some places in appreciable amounts. Chlorite is common. Here, in contrast to the white quartz of the bedded veins, the quartz is light bluish-grey. The ankerite was introduced after the quartz, but it is cut by veinslets containing sericite. All three gangue minerals preceded the sulphides. Pyrrhotite and pyrite are the most abundant sulphides, but locally galena and sphalerite are more common than the iron sulphides. Chalcopyrite is relatively scarce, but can usually be seen in the ore, whereas arsenopyrite was recognized only in polished sections. Pyrite apparently was deposited at two
different periods, One generation is cut by pyrrhotite and replaced by it, whereas the other clearly occurs in veinlets cutting pyrrhotite. Sphalerite, chalcopyrite and galena were deposited approximately in the order named. Pentlandite, the nickel-iron sulphide, which is commonly associated with large bodies of pyrrhotite, was not recognized, and the specimens containing abundant pyrrhotite from the Grey Eagle that were tested did not react for nickel.

The Gold Back lode is said to contain some gold, but few data on the gold content are available to the writer. Samples of Gold Back ore that have been assayed apparently contained from a trace to 0.06 ounces of gold to the ton. Galena and sphalerite occur as shoots and bunches in the lode, in places of sufficient grade to form ore, but thus far no shoots of commercial size have been found.