Geology of the Murray Area Shoshone County Idaho

By JOHN W. HOSTERMAN

A CONTRIBUTION TO ECONOMIC GEOLOGY

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Geology of the Murray area and description of the lead-zinc deposits

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A CONTRIBUTION TO ECONOMIC GEOLOGY

GEOLOGY OF THE MURRAY AREA, SHOSHONE COUNTY, IDAHO

By John W. Hosterman

ABSTRACT

The Murray area includes almost the whole drainage basins of Prichard, Eagle, and Beaver Creeks and is underlain by the pre-Cambrian Belt series which is subdivided, from oldest to youngest, as follows: Prichard formation (upper and lower parts), Burke formation, Revett quartzite, St. Regis formation, Wallace formation, and Striped Peak formation. The Belt series in this area is cut by many small monzonite stocks believed to be related to the Cretaceous Idaho batholith.

This report describes only the lead-zinc mines. The lead-zinc production around Murray reached its peak in 1911 and 1912 when the Monarch, Edith Murray (Pontiac or Terrible Edith), Bear Top, Paragon, Black Horse, and Silver Strike mines were active. Many of these mines have produced ore intermittently since then, and the Jack Waite mine has been very active since about 1930.

INTRODUCTION

Reconnaissance mapping of the Murray area was undertaken to determine the relations of its major geologic features to those of the main Coeur d'Alene district. Also, an areal geologic map was made of the gap between the Mullan [1] and Pottsville [2] quadrangles and the northern part of the Trout Creek quadrangle (Gibson and others, 1941, pl. 1).

During the summer of 1935 the U. S. Geological Survey, in cooperation with the Idaho Bureau of Mines and Geology, undertook a study of the gold-tungsten deposits of the Murray district. The work described in the present report, done during 1953, does not repeat the work in 1935 of Shenon (1938) but extends the geologic mapping into the region surrounding the Murray area. No study was made of the mineral deposits discussed in detail by Shenon (1938) because most of these mines are now inaccessible and very little if any additional work has been done since Shenon mapped them in 1938.

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[1] Griggs, A. B., Wallace, R. E., and Hobbs, S. W., 1953, Geologic map and structure sections of the Mullan and vicinity quadrangle, Idaho: U. S. Geol. Survey open-file map.

[2] Wallace, R. E., and Hobbs, S. W., 1952, Geologic map of the Pottsville quadrangle, Shoshone County, Idaho: U. S. Geol. Survey open-file map.

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LOCATION AND ACCESSIBILITY

The Murray area (fig. 87) includes most of the drainage basins of Prichard, Eagle, and Beaver Creeks and parts of the Beaver, Coeur d'Alene, Eagle, and Summit mining districts. It is bounded on the east by the Idaho-Montana State line, on the west by Beaver Creek and the Coeur d'Alene River, on the south by the Mullan and Pottsville quadrangles, and on the north by the West Fork of Eagle Creek and Cottonwood Creek. A strip about 2 miles wide on the southern edge of the map is common with the northern edge of the Mullan and Pottsville quadrangles.

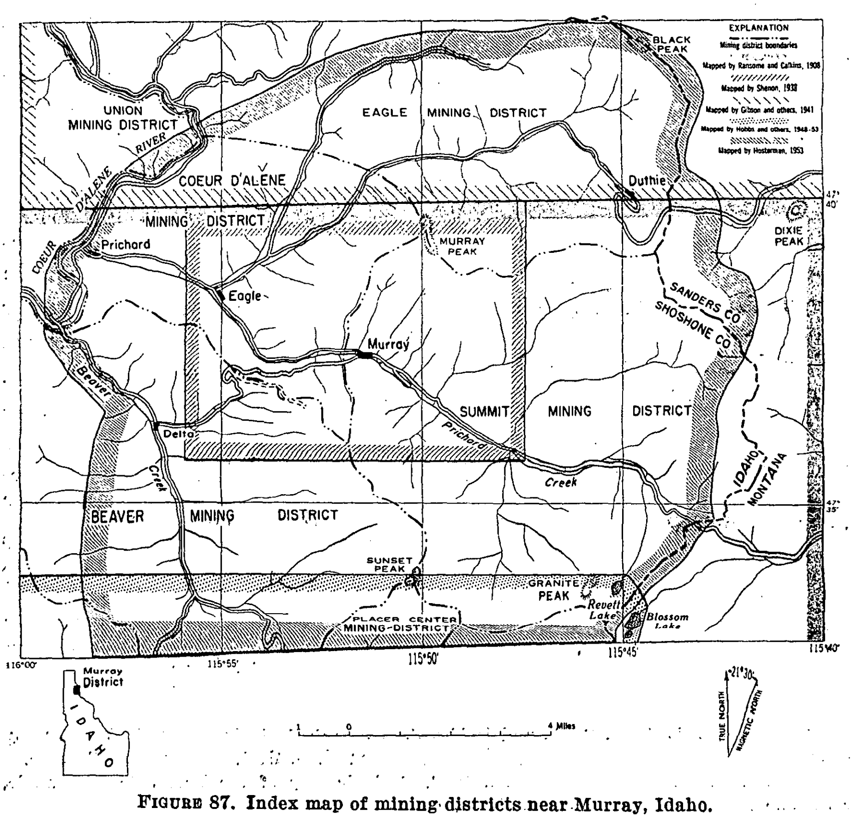

FIGURE 87. Index map of mining districts near Murray, Idaho.

There are five towns within the area mapped: Murray, Prichard, Eagle, Duthie, and Delta (fig. 87). Murray, the largest, has a population of about 300 and was once much larger and more prosperous; but, like Prichard and Eagle, it is now supported by the lumber industry. Duthie is supported entirely by the Jack Waite mine and mill. Delta was once a major town in the area but now is a road junction with only two houses.

The area is traversed by several all-weather dirt roads. Prichard and Murray are each about 20 miles from Wallace, county seat of Shoshone County. Duthie is about 34 miles from Wallace. The road from Wallace to Murray crosses two summits—Dobson Pass at an altitude of 4,179 feet and Kings Pass at an altitude of 3,321 feet. A road along the Coeur d'Alene River joins U. S. Highway 10 at Enaville, 29 miles southwest of Prichard. There is also a poor road from Murray to Thompson Falls, Mont., and another poor road from Duthie to Whitepine, Mont.

The area mapped lies within the Coeur d'Alene Mountains, a part of the northern Rocky Mountains physiographic province. Generally the streams have cut step-sided narrow valleys. The lowest altitude is about 2,500 feet, at Prichard; the highest altitude is 6,800 feet, at Granite Peak. The maximum relief is about 4,300 feet. The ridges are heavily timbered, and a dense secondary growth on burned-over slopes makes geologic observations difficult. There are a few slopes that are so steep that no vegetation will survive. An example of this is a place along the Coeur d'Alene River near Prichard.

GEOLOGY

SEDIMENTARY ROCKS

The subdivision of the pre-Cambrian Belt series in the Coeur d'Alene district and surrounding area set up by Calkins (Ransome and Calkins, 1908, p. 23), from oldest to youngest, is as follows: Prichard formation, Burke formation, Revett quartzite, St. Regis formation, Wallace formation, and Striped Peak formation. The contacts between these formations are gradational and are, therefore, arbitrarily defined. The Belt series has been estimated to have a total thickness of about 40,000 feet in the Libby quadrangle, Montana (Gibson, 1948, p. 8). In the Coeur d'Alene district, however, the thickness of the Belt series has been calculated as ranging from 21,000 to 27,000 feet; neither the top nor the bottom of the section is exposed.[3] In the Murray area, the thickness of the Belt series is about 25,000 feet; the top is eroded away and the bottom is not exposed.

[3] Griggs, A. B., 1952, Geology and notes on ore deposits of Canyon-Nine Mile Creeks area, Shoshone County, Idaho: U. S. Geol. Survey open-file report, p. 11.

PRICHARD FORMATION

In the Murray area the Prichard formation has been divided into two mappable units based on lithology. The two divisions are referred to as the upper part and the lower part of the Prichard formation. The term "lowest part," however, is misleading because the lowest part or base of the Prichard formation is not exposed in the Murray district. Therefore, the lower part of the Prichard formation includes all of the formation observed except the upper 1,800 feet.

Rocks of the Prichard formation underlie almost the entire drainage basin of Prichard Creek and its tributaries (pl. 57). In Bear Gulch about 9,000 feet of the lower part of the Prichard formation is exposed in the core of the Trout Creek anticline. This lower part is about 75 to 80 percent dark-gray argillites and 20 to 25 percent light-brownish-gray fine-grained impure quartzites. The bedding is usually regular. Individual beds average 2 to 6 inches thick and are rarely more than 12 inches; but a few quartzite beds are as much as 5 feet thick. In many places the argillaceous rocks are laminated, and the visibility of these laminae ranges from slight to pronounced. The individual laminae range in thickness from 0.01 to 10 millimeters and occur as alternating light-gray coarser grained layers and dark-gray finer grained layers. Pyrite is found along many bedding planes, and the limonite derived from the weathered pyrite coats the rock a moderate-brown color.

The upper part of the Prichard formation forms a transition zone between the lower part and the overlying Burke formation. It is well exposed along the ridge running northwest from Goose Peak, where it is about 1,800 feet thick; it is also exposed near the heads of Bear and Paragon Gulches and along both the East and West Forks of Eagle Creek. The upper part contains quartzite and argillite in roughly a 2 to 1 ratio, which represents almost twice as much quartzite as the lower part and about one-half as much quartzite as the Burke formation. The quartzite ranges in appearance from thin bedded, impure, and greenish gray near the base to thick bedded, pure, and light gray to white near the top. The argillite is thinly laminated; the dark-gray fine-grained material alternates with light-gray coarser grained material. The individual laminae are rarely more than 1 millimeter in thickness. The argillite beds are more abundant near the base and become fewer until they disappear near the top.

BURKE FORMATION

The Burke formation is exposed along the East Fork of Eagle Creek, along Cottonwood Creek, at the head of Paragon Gulch, and in the cliffs surrounding Revett Lake (pl. 57). At none of these localities is the entire formation well exposed, but the average thickness is probably somewhere between 2,200 and 2,500 feet. Near the base of the Burke formation the rocks consist of medium- to light-greenish-gray impure quartzite. This quartzite is interbedded with a few beds of more massive light-gray to white pure quartzite that disappears near the center of the formation. From the center to the top of the formation the quartzite beds commonly become less and less argillaceous, and the greenish-gray color gradually changes to a light-bluish-gray color. The contact between the Burke formation and the overlying Revett quartzite is within a transition zone which is several hundred feet thick. The contact is usually placed where massive very light gray to white pure quartzite becomes predominant. Medium-gray to light-gray argillaceous beds occur as thin interbeds throughout the formation, particularly near the base.

REVETT QUARTZITE

Cliffs of Revett quartzite can be observed on lower Beaver Creek near its junction with the Coeur d'Alene River and up the river for several miles (pl. 57). In the Murray area the Revett is approximately 2,200 to 2,400 feet thick. Except for the transition zone with the underlying Burke formation, the Revett quartzite is uniform throughout the entire section. It consists of fine- to medium-grained almost-white pure quartzite; beds are usually 1 to 6 feet thick and some are as much as 15 feet thick. Throughout the formation a few thin greenish-gray argillite beds are found. Well-developed cross-bedding is characteristic of much of the formation. Splotchy iron-oxide staining of the weathered surfaces of the quartzite to a red or brown color is very common.

ST. REGIS FORMATION

The distinction between the underlying Revett quartzite and the St. Regis formation is based on the purplish-gray color of the latter. Between the two formations there is a transition zone of about a hundred feet composed of massive white quartzite interbedded with purplish-gray quartzite. This zone is well exposed in the cliff above the East Fork of Eagle Creek opposite Saw Gulch and just below Little Baldy Peak (pl. 57). In the upper part of the section, the purple quartzite beds give way in a short distance to purplish-gray thin-bedded argillites. The upper part of the St. Regis formation has been eroded away at Little Baldy Peak, but it is present near Capital Hill where it has a thickness of about 2,000 feet. The upper several hundred feet of purplish-gray thin-bedded argillite is interbedded with greenish-gray laminated argillite.

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WALLACE FORMATION

The Wallace formation is not well exposed in the Beaver Creek valley where it is most extensive; but, if no faults exist here, the Wallace formation is about 8,000 feet thick, as shown on the geologic map (pl. 57). The greenish-gray laminated argillite of the St. Regis formation grades rather suddenly into the interbedded light-gray quartzite and dark-gray argillite of the Wallace formation. A few dense bluish-gray carbonate beds as much as several feet thick occur in the lower part of the Wallace formation. The most typical rock of the upper part of the Wallace formation is a finely laminated argillite, not unlike the rocks of the upper part of the Prichard formation, composed of alternating muddy and sandy laminae that are approximately 1 millimeter thick. The features which do help distinguish the Wallace formation from the upper part of the Prichard formation are the slightly crumpled bedding and the light-olive and light-brownish-gray colors on the weathered surfaces. The colors are due to the oxidation of the iron-bearing carbonate minerals.

STRIPED PEAK FORMATION

The Striped Peak formation, the youngest unit of the Belt series, is poorly exposed in two places along the Dobson Pass fault (pl. 57). The northern exposure lies conformably upon the Wallace formation, and the southern exposure is bounded by two faults that dip 30° toward each other.[4] In the northern exposure the top of the Striped Peak formation has been eroded away, leaving only the bottom several hundred feet. Where exposed, the Striped Peak formation consists of grayish-purple to dark-red impure quartzite in beds that range from 1 to 4 inches in thickness. There are a few dark-red to dark-gray argillaceous partings. Shallow-water features, such as mud cracks, ripple marks, and mud chips, are quite common.

UNCONSOLIDATED SEDIMENTS

Near Eagle, the older gravels form terraces that range from about 200 to 1,000 feet above the river. The boundaries of these gravels are hard to determine because the pebbles, cobbles, and boulders tend to creep downhill over the underlying bedrock. These gravels consist of unconsolidated material ranging in size from clay to boulders, and they are derived from the formations within the Murray area. A faint stratification can be noticed.

Recent deposits of silt, sand, gravel, and peat are found covering the valley floors of Prichard Creek, the Coeur d'Alene River, and Beaver Creek. Peat deposits are exposed in small drift mines along Prichard Creek (Shenon, 1938, p. 14). They average 2 to 3 feet in thickness and are generally 3 to 5 feet above bedrock.

[4] See footnote 3 on page 727.

IGNEOUS ROCKS

The monzonite stocks of the Mullan quadrangle,[5] and the smaller monzonite stocks in the Murray area and in the Trout Creek quadrangle to the north (Gibson and others, 1941, pl. 1), have a good alinement in an almost northeasterly direction. The control of this alinement by a zone of weakness is not apparent, but the stocks are close to the axis of an anticline.

The largest exposure of a monzonite stock within the mapped area is in Granite Gulch (pl. 57). The workings of the Giant Ledge mine show that the eastern side of this stock is faulted against the lower part of the Prichard formation by the French Gulch fault. Four much smaller bodies of monzonite which cut the lower part of the Prichard formation can be seen on the ridge between Bear and Paragon Gulches near Prichard Creek. All these igneous bodies have a wide range in composition and texture; it would be very difficult to map the various facies because of the intricate transition from one kind of rock to another and because of the lack of outcrops. The prevailing rock is a porphyritic light-gray monzonite. Some of the phenocrysts exceed 5 centimeters in length; in the groundmass the feldspars average about 1 millimeter. Toward the margins of stocks, and in the smaller bodies the monzonite commonly becomes more mafic and grades into rather fine equigranular dark-gray rock which is more dioritic in composition. Near the center of the stock, however, the monzonite body grades into more porphyritic very light gray rock which is probably more syenitic in composition and has few mafic minerals.

The prevailing rock type is composed largely of plagioclase (oligoclase) and some microcline. The accessory minerals are predominantly greenish-black hornblende and some pyroxene, magnetite, apatite, and quartz. Biotite, garnet, and zircon make up the minor minerals. The secondary minerals are epidote, sericite, and some chlorite.

Several dikes have been found in the Murray area; but, as they generally weather more rapidly than the rocks they cut, their outcrops are inconspicuous or absent. Dike rocks have been found at the following places: near the mouth of Cement Gulch; a little less than 2 miles east of Horseshoe Peak; near the mouth of Reeder Gulch (in the Golden Chest mine); about 1 mile up Tiger Gulch; in Ferguson Creek valley; and, about one-half mile up Dream Gulch. The dikes in the Murray area are generally considerably altered and too fine grained to be readily named in the field.

There are, however, several rock types that are identifiable under the microscope. The dikes exposed near Cement Gulch and east of Horseshoe Peak are fine-grained dark-greenish-gray diabase dikes

[5] See footnote 1 on page 725.

(Shenon, 1938, p. 9). Samples from both these localities show that the original constituents have been almost entirely hydrothermally altered and the original diabasic texture has been nearly obliterated. The composition of the other dikes found in the Murray area is doubtful, but they are probably either lamprophyre or monzonite dikes. One feature of all the specimens was the almost complete replacement of the original plagioclase by albite. According to Shenon (1938, p. 10), this albitization is common in many of the lamprophyre and monzonite dikes elsewhere in the Coeur d'Alene district.

STRUCTURE

The largest structure of the Murray area is the Trout Creek anticline that can be traced from Prichard Creek north to the Trout Creek ranger station, a distance of approximately 18 miles. It dies out to the north against the Hope fault and to the south it terminates against the Thompson Pass fault at Prichard Creek. The only logical extension of the anticline south of the Thompson Pass fault would be the anticline exposed in Ophir and Idaho Gulches. The southern part of the anticline would be offset to the west. The axis of the anticline trends in a north to northeast direction. In the Trout Creek quadrangle (Gibson, Jenks, and Campbell, 1944, pl. 1) the outcrop pattern shows that the anticline is asymmertical and the west limb much steeper than the east limb. Farther south in this area, however, the east limb steepens from about 20° to 30° near the Jack Waite mine to almost vertical and overturned in Bear and Paragon Gulches. The west limb, on the other hand, has a relatively constant 40° to 50° dip throughout.

West of and parallel to the Trout Creek anticline is the Eagle Creek syncline which also has a north to northeast trend. This syncline can be traced only for about 5 miles. It is terminated on the north end by a fault (Gibson, Jenks, and Campbell, 1941, pl. 1) and on the south end by the Murray Peak fault. The Eagle Creek syncline is almost symmetrical; both limbs dip 20° to 30° toward each other.

Both steep-dipping reverse and normal faults are found in the area. One of the largest, the Dobson Pass fault, has been traced for about 10 miles. The relation of the formations in the hanging wall and footwall indicates a normal relative movement, and exposures in the Day Rock mine to the south indicate a west dip of about 30°.[6] To the north, the McComber fault is probably the continuation of the Dobson Pass fault. According to Shenon (1938, p. 14), the McComber fault had normal movement, and the relation of its trace to the topography shows that the westerly dip increases to the north. There are, however, no underground workings exposing the McComber fault, so its attitude

[6] See footnote 3 on page 727; p. 87.

is somewhat questionable. The Dobson Pass and McComber faults bring the Wallace and Striped Peak formations in contact with the lower part of the Prichard formation. Therefore, the minimum vertical displacement for these faults in this area would be 16,200 feet.

East of the McComber fault is the Murray Peak fault which can be traced for about 5 miles in the mapped area. Gibson (Gibson, Jenks, and Campbell, 1941, pl. 1) shows that this fault or splits from it can be traced at least 20 miles north in the Trout Creek quadrangle. The Murray Peak fault has brought the lower part of the Prichard formation on the west in contact with St. Regis formation on the east, a minimum displacement of about 6,200 feet. The relation of its trace to the topography shows that the Murray Peak fault is almost vertical. Where the Murray Peak fault has Prichard formation on both sides, it cannot be traced accurately; however, the best evidence shows that it is cut off to the south by the Thompson Pass fault. Shenon (1938, pl. 1) shows the Murray Peak fault continuous with the Thompson Pass fault. This can hardly be possible because the two faults have opposite relative displacements.

The Thompson Pass fault can be traced for at least 7 miles in Idaho, and it has been followed for about 10 miles in Montana. The dip of the fault is not known, but its excellent topographic expression in Montana indicates that it is almost vertical. The fault's location west of Idaho Gulch is questionable, but in all probability the main fault zone splits into many small faults that die out in a relatively short distance. It is possible that the Kings Pass fault may be the western extension of the Thompson Pass fault, and the extreme shattering near Kings Pass may be due to the intersection of the Thompson Pass-Kings Pass fault with the McComber-Dobson Pass fault. According to Calkins (Ransome and Calkins, 1908, pl. 2), the Thompson Pass fault brings the St. Regis formation in contact with the lower part of the Prichard formation in Montana; therefore, the minimum apparent vertical displacement would be approximately 6,200 feet.

The Kings Pass fault can be traced west from a point where it is cut off by the Ucelly fault to the Coeur d'Alene River, where it seems to die out in the Revett quartzite. From its topographic expression, it is estimated that this fault dips approximately 70° to 85° to the south; and, as the Burke formation on the north is against the Revett quartzite on the south, it is a normal fault. The displacement is undoubtedly somewhat less than 2,000 feet. The two faults parallel to the Kings Pass fault are cut off to the west by a north-striking fault and to the east by the Dobson Pass fault. Because of the many other complex faults, which were not mappable, the rocks in this area are very badly crushed and altered and structural relations are extremely complex.

A fault zone about 100 feet thick was found 1,000 feet in from the portal of the lower workings of the Silver Strike mine in Granite Gulch. This fault is believed to be the northern extension of the O'Neill Gulch fault.[7] According to Griggs[8] the displacement in O'Neill Gulch and Canyon Creek valley is over 3,000 feet vertically. The relative movement in Granite Gulch, however, is less than 1,000 feet. In Granite Gulch the O'Neill Gulch fault coincides with the axis of an anticline for a short distance. The O'Neill Gulch fault terminates against the monzonite stock found in Granite Gulch. It is a very steep reverse fault and was observed to dip 75° E. in the Tiger-Poorman mine (Ransome and Calkins, 1908, p. 173).

About one-half mile east of the O'Neill Gulch fault, the French Gulch fault forms the fault contact between a monzonite stock and the lower part of the Prichard formation. This reverse fault can be traced from the mouth of French Gulch (Ransome and Calkins, 1908, pl. 2) to the mouth of Granite Gulch (pl. 57), approximately 4 miles. In the Giant Ledge prospect, the French Gulch fault strikes N. 30° W. and dips 85° NE; in Granite Gulch the relative movement is less than 1,000 feet. The French Gulch fault is terminated on the north against the Thompson Pass fault.

MINERAL DEPOSITS

Shenon (1938, p. 18) has divided the ore deposits near Murray into four structural groups which are as follows: (1) mineralized shear zones that usually cut across bedding at steep angles; (2) quartz veins that lie approximately along bedding; (3) quartz veins that lie along low-angle thrust faults (similar in composition to the second group); and (4) placer deposits. The mineralized shear zones are replacement veins along minor fractures and shears where the movement has been relatively small. The ore of the mineralized shear zones occurs in tabular bodies which are irregular in shape and are usually steep dipping (an exception is the Jack Waite vein which has a dip as low as 15°). Commonly, they are longer vertically than horizontally; the individual ore bodies range in thickness from almost nothing to as much as 50 feet, but they average about 2 feet thick. The approximate order of mineralization is as follows: pyrite, magnetite (if present), chlorite, carbonate, quartz (dark colored), pyrrhotite, sphalerite (dark), galena, and quartz (white).

The bedding-plane veins are also replacement veins; the economic metals are gold and some tungsten. In general, the veins of this group lie along the bedding of the thinly laminated dark-gray argillite of the lower part of the Prichard formation, but the lithologic

[7] See footnote 1 on page 725.
[8] See footnote 3 on page 727; p. 72.

character of the rocks has had little or no control on localizing the ore. Where the bedding is sharply folded the veins leave the bedding and follow fractures. Most of the bedding veins are less than 3 feet thick, but in places veins reach a thickness of 10 feet as in the Katie-Dora ore shoot of the Golden Chest mine (Shenon, 1938, fig. 11). The approximate sequence of deposition according to Shenon (1938, p. 20) is as follows: coarse-grained white quartz, sheelite, fine-grained white quartz, carbonate, specularite, pyrite, arsenopyrite, sphalerite (dark), chalcopyrite, and galena. (In other veins in most of the Couer d'Alene district, however, the carbonate is very definitely older than the white quartz.) Gold was found cutting all the sulfides and, therefore, was the last to be deposited. Sulfides (and gold) make up about 5 percent of the bedding-plane veins; the gold ranges from a trace to 20 ounces per ton. The percentage of scheelite in the veins is small, but it occurs occasionally in relatively pure bodies. According to Shenon (1938, p. 22), the relation of the mineralized shear zones to the bedding-plane veins, as seen in the Mother Lode mine, indicates that at least part of the mineralization of the shear zones preceded that of the bedding-plane veins and that movement along the shear zones was recurrent after the formation of the bedding-plane veins.

The Wake Up Jim mine is the only property that has a quartz vein which occurs along a low-angle thrust. The rocks in the footwall of the thrust are almost vertical, whereas those in the hanging wall range from horizontal to 30°. The vein occurs as lenticular bodies of irregular outline along the thrust fault; it is similar in composition and sequence of mineralization to the bedding-plane veins already mentioned. The gold content probably averaged between 1 and 2 ounces per ton.

The placer deposits in the Murray area can be divided into two classes: terrace gravels several hundred feet above the present streams and alluvial deposits of the present streams. The placer deposits along the present streams were the first to be worked by the early prospectors; they were also the richest. As pointed out by Ransome and Calkins (1908, p. 49), the present stream deposits represent a final stage in the process of natural concentration and are, therefore, richer than the terrace gravels. According to Shenon (1938, p. 24), the fineness of the gold along Prichard Creek ranged from 770 to 830 and was generally finer than the gold from the higher terrace gravel placers. Some gold has been recovered from the terrace gravels, but large areas still remain unworked in the Murray area. Most of the gold mined from these upper gravels was found on or near the underlying bedrock, and one of the more common ways of mining it was to drive an adit in bedrock and raise up to the base of the gravels.

Shenon (1938, p. 26–44) has described in excellent detail the gold-tungsten mines in the immediate Murray area, and these descriptions will not be repeated here. Furthermore, almost all of these mines have been inactive since the midthirties and, therefore, are considerably less accessible than they were when Shenon mapped the area in 1935. The following mines are described by Shenon: Golden Chest, Mother Lode, Four Square, Buckeye Boy, Dew Drop, Wake Up Jim, Tiger, Edith Murray (Pontiac), and Anchor, as well as many small prospects. Many mines (and prospects) on upper Beaver Creek and Carbon Creek are not described in this report because they will be included in a report by the U. S. Geological Survey on the Coeur d'Alene district veins.

The following mines and prospects are all mineralized shear zones in which the metals mined are lead and zinc. The lead-zinc production around Murray reached its peak in 1911 and 1912 when the Monarch, Edith Murray (Pontiac or Terrible Edith), Bear Top, Paragon, Black Horse, and Silver Strike were active. Many of these mines produced intermittently on a small scale until 1951 (table 1). The only mine active at the time of the fieldwork for this report was the Jack Waite mine.

TABLE 1. *Gold, silver, copper, lead, and zinc produced by mining districts in the Murray area from 1935 to 1951* [1]

	1935	1936	1937	1938	1939	1940	1941	1942	1943
Gold production, in ounces									
Beaver [2]	72	42	384	19	413	2,269	358	126	97
Coeur d'Alene [3]	216	284	223	91	107	63	46	15	
Eagle (Idaho)	4	5	4	6	20	1	12		4
Eagle (Mont.)	22	64	84	79	57	71	76	38	30
Summit [4]	480	95	364	1,481	3,291	2,292	798	33	17
Total	794	490	1,059	1,676	3,888	4,696	1,290	212	148
Silver production, in ounces									
Coeur d'Alene [3]	36	53	31	20	15	14	14	7	
Eagle (Idaho) [5]			3,448	6,367	7,425	997	1,236		1,274
Eagle (Mont.) [6]	9,440	27,654	38,437	35,377	25,706	35,602	32,483	20,025	15,421
Summit	192	18	905	1,038	2,550	1,516	588	7	308
Total	9,668	27,725	42,821	42,802	35,696	38,129	34,321	20,039	17,003
Copper production, in pounds									
Coeur d'Alene									
Eagle (Idaho) [5]			4,000		8,346		200		900
Eagle (Mont.) [6]	12,024	29,913	57,281	44,296	30,827	53,168	18,800	17,000	43,500
Summit	1,988		694	1,265	5,154	2,292	700		
Total	14,012	29,913	61,975	45,561	44,327	55,460	19,700	17,000	44,400
Lead production, in pounds									
Coeur d'Alene									
Eagle (Idaho) [5]			856,000	1,543,000	1,875,490	245,700	90,300		95,000
Eagle (Mont.) [6]	2,241,675	6,225,239	9,264,899	8,602,696	6,503,298	8,215,080	6,588,900	3,997,600	3,160,400
Summit	1,925		90,000	74,391	75,447	70,740	24,400		16,000
Total	2,243,600	6,225,239	10,210,899	10,220,087	8,454,235	8,531,520	6,703,600	3,997,600	3,271,400

Zinc production, in pounds

Coeur d'Alene									
Eagle (Idaho) [5]			108,400	207,417	232,346	16,460	3,600		28,000
Eagle (Mont.) [6]	2,230,068	1,442,540	1,264,000	1,100,000	787,000	835,000	2,095,000	696,000	512,500
Summit			13,000	14,250	22,693	26,968	26,400		
Total	2,230,068	1,442,540	1,385,400	1,321,667	1,042,039	878,428	2,125,000	696,000	540,500
Total value	$135,770	$447,492	$791,420	$624,359	$616,425	$679,658	$613,361	$356,294	$326,772

See footnotes at end of table.

TABLE 1. *Gold, silver, copper, lead, and zinc produced by mining districts in the Murray area from 1935 to 1951* [1]—Continued

	1944	1945	1946	1947	1948	1949	1950	1951	Total 1935–51
Gold production, in ounces									
Beaver [2]	118	210	82	220	411	110	206	73	5,210
Coeur d'Alene [3]	3		3	29	1				1,081
Eagle (Idaho)	2	18	16	6	4			2	104
Eagle (Mont.)	17	9	8	9	13	20	19		616
Summit [4]		3	27	239	106	37		1	9,264
Total	140	240	136	503	535	167	225	76	16,275
Silver production, in ounces									
Coeur d'Alene [3]			2,323	10				895	3,418
Eagle (Idaho) [5]	1,125	7,259	6,510	1,800					37,441
Eagle (Mont.) [6]	10,350	5,580	4,052	4,032	5,824	8,436	8,932	6,511	293,862
Summit		225	339	1,968	1,674	231	147	1,328	13,034
Total	11,475	13,064	13,224	7,810	7,498	8,667	9,079	8,734	347,755
Copper production, in pounds									
Coeur d'Alene			500						500
Eagle (Idaho) [5]	1,600	9,600	3,500	600				2,400	31,146
Eagle (Mont.) [6]	22,200	11,400	13,500	16,800	16,000	12,500	14,000		413,209
Summit		400	1,000	3,500	2,300	600	300	1,700	21,893
Total	23,800	21,400	18,500	20,900	18,300	13,100	14,300	4,100	466,748
Lead production, in pounds									
Coeur d'Alene			85,000						85,000
Eagle (Idaho) [5]	76,900	581,500	450,000	156,000				83,700	6,053,590
Eagle (Mont.) [6]	2,256,100	1,197,500	938,000	786,000	1,199,500	2,047,700	2,026,800	1,251,800	66,503,187
Summit		40,500	69,000	429,500	117,000	20,200	16,800	216,400	1,262,303
Total	2,333,000	1,819,500	1,542,000	1,371,500	1,316,500	2,067,900	2,043,600	1,551,900	73,904,080

Zinc production, in pounds

Coeur d'Alene			65,000						65,000
Eagle (Idaho) [5]	5,500	19,400	50,000	13,000				1,700	685,823
Eagle (Mont.) [6]	183,500	207,000	170,500	253,800	251,800	304,000	352,900	645,800	11,331,408
Summit		30,000	33,000	175,000	90,800	19,000	63,500	242,000	756,611
Total	189,000	256,400	318,500	441,800	342,600	323,000	416,400	889,500	12,838,842
Total value	$224,459	$206,542	$225,377	$280,016	$310,702	$383,050	$354,081	$447,621	$7,023,399

[1] Data from U. S. Bureau of Mines Minerals Yearbooks, 1936–51.
[2] The largest producer of gold in the Beaver mining district was the Potosi Placer from 1935 to 1948. The figures do not include the silver production of the district.
[3] The largest producers of gold and silver in the Coeur d'Alene mining district from 1935 to 1941 were the Mountain Lion and Beehive mines (Shenon, 1938, pl. 1).
[4] The main producers of gold in the Summit mining district were the Mother Lode and Golden Chest mines.
[5] In the Idaho part of the Eagle mining district, the Jack Waite mine was the only producer from 1937 to 1941, and the Crystal Lead mine was the only producer from 1943 to 1951. Therefore, the total production from the Crystal Lead mine from 1943 to 1951 is as follows: 18,863 ounces of silver; 18,600 pounds of copper; 1,443,100 pounds of lead; and 117,600 pounds of zinc. Data from U. S. Bureau of Mines Minerals Yearbooks, 1936–51.
[6] In the Montana part of the Eagle mining district, the Jack Waite mine was the only base-metal producer from 1935 to 1951. Therefore, the total production from the Jack Waite mine (both Idaho and Montana) from 1935 to 1951 is as follows: 313,335 ounces of silver; 425,755 pounds of copper; 71,113,677 pounds of lead; and 11,899,631 pounds of zinc. Data from U. S. Bureau of Mines Minerals Yearbooks, 1936–51.

JACK WAITE MINE

The Jack Waite mine (pl. 58) at Duthie on Tributary Creek, a branch of the East Fork of Eagle Creek, is about 6 miles northeast of Murray and 30 miles northeast of Wallace, Idaho, the nearest rail point. According to the story told by the local people, in the old days the main trail from Thompson Falls, Mont., to Murray was up Beaver Creek to the divide and then down Butte Gulch. In about 1900 Jack Waite was making this trip when he became lost near the divide, and instead of going down Butte Gulch he started down Tributary Creek. There he found the outcrop of the vein that has produced almost steadily since that time. The Jack Waite Mining Co. worked the property until the midthirties; it was leased then to the American Smelting & Refining Co. which has worked the mine since. Table 1 shows the production of the Jack Waite mine from 1935 to 1951 to be as follows: 313,335 ounces of silver, 425,725 pounds of copper, 71,113,677 pounds of lead, and 11,899,631 pounds of zinc. The mine has about 24,000 feet of drifts and crosscuts and several thousand feet of raises and winzes. The mine is divided in half by the Idaho-Montana State line; both sides can be reached through the adit of the 1500 level which has its portal about one-half mile upstream from the town of Duthie. The Idaho side, now inaccessible above the 1500 level, was at one time open through an adit of the 1000 level. The Montana side of the mine is also accessible through the 100 level which has its portal near the head of Beaver Creek in Montana. The ore, however, mined from the Montana side is lowered down through the Montana raise to the 1500 level and out to the mill at Duthie. Workings below the 1500 level on both the Idaho and Montana sides are under water.

The Jack Waite vein is a mineralized shear zone striking about N. 60° W. and dipping 45° to 55° SW. The shear zone has been exposed along its strike for about 5,500 feet on the 1500 level and downdip for about 1,700 feet. The ore occurs in shoots which generally have a southeastern rake, although a few ore shoots have a southwestern rake. This pattern is especially noticeable on the Montana side of the mine where more careful stope mapping has been done. The vein ranges in thickness from less than 1 inch to 12 feet; an average stope width is about 5 feet. The ore minerals are galena and sphalerite; the principal gangue is quartz, carbonate minerals, and country rock, which is the lower part of the Prichard formation. The ore is commonly, but not always, found on the footwall of the shear zone, which has several inches of gouge. In the stopes on the Montana side of the mine secondary shears that diverge upward from the main Jack Waite shear have been observed. At the junctions of these secondary shears and the main shear zone the country rock has been extremely broken and shattered. It seems quite possible that these junctions have played an important part in localizing the ore. Smeared and shattered galena indicates postmineralization movement. The lithologic character of the enclosing rocks does not seem to have had any control of the placement of the ore. The bedding of the lower part of the Prichard formation dips from 20° to 40° to the northeast.

CRYSTAL LEAD MINE

The Crystal Lead mine (pl. 59), on Cottonwood Creek which is a tributary to the West Fork of Eagle Creek, is about 6 miles north of Murray. The Day Mines, Inc. of Wallace owns the Crystal Lead property, but all of the production has been by lessors. The mine produced 18,863 ounces of silver, 18,600 pounds of copper, 1,443,000 pounds of lead, and 117,600 pounds of zinc from 1943 to 1947 and in 1951 (table 1). The Crystal Lead mine consists of 5,000 feet of drifts and crosscuts on 4 main and 3 intermediate levels, and it has about 500 feet of raises and winzes. The vein is a mineralized shear zone striking about N. 35° W. and dipping 80° SW. Level 4, which was the only level accessible in 1953, exposes the shear zone for 1,250 feet. The only ore shoot found in the mine on this shear has a steep southeast rake. The ore shoot has a strike length of about 120 feet on level 4 and a vertical length of about 440 feet between level 2 and 40 feet below level 4; it ranges in width from less than 1 inch to 5 feet. Normally, the mineralized rock is in the footwall of the shear zone but at a few places it is bounded on both sides by faults. The ore minerals are galena and sphalerite; the gangue is mostly quartz, some carbonate minerals, and country rock. The ore minerals are extremely irregular in occurrence, which makes prospecting expensive and risky. The lithologic character of the enclosing Burke formation does not seem to have had any control on the placement of the ore; but, as in the Jack Waite mine, junctions of the main shear zone and secondary shears have been important in ore control. The beds of the Burke formation dip from normal to 75° W. at the level 4 crosscut but are overturned 80° E. near the east end of the level 4 drift. These beds are on the steep-dipping west limb of the Trout Creek anticline.

MONARCH MINE

The portal of the 1440 level of the Monarch mine (pl. 60) is near Prichard Creek and is about 5 miles east of Murray. The portal of the 300 level of the mine is in Barton Gulch, about 1 mile south of the 1400 level portal. This mine reportedly has produced lead and zinc ores intermittently since 1905. The Monarch mine has about 10,650 feet of crosscuts and drifts, of which about 6,550 feet are on the 1400 level. It has approximately 1,200 feet of raises and winzes.

The 1400 level is connected to the 600 level by the 875-foot *C* raise, and the 600 level is connected to the 300 level by the 237-foot *A* raise. The veins in the Monarch mine belong to the mineralized shear zone type; they have a strike of about N. 45° W. and dips ranging from vertical to 75° NE. On the 300 level there are two veins, about 15 to 30 feet apart, that have transverse veins trending east between them; the southwestern vein has been mined extensively below the 300 level. The same pattern seems to exist on the 400 level, and the ore mined between the 600 and 1000 levels is probably the southwestern vein. The vein exposed and mined on the southeastern end of the 1200 and 1400 levels is about 200 feet northeast of the projected position of the veins exposed in the upper levels. The relations of the veins found in the Monarch are uncertain because part of the mine is inaccessible and the past exploration was not detailed enough. On the 1400 level two drifts, the Barton drift 1,100 feet from the portal and the Atlantic drift 2,400 feet from the portal, follow structures that contain barren quartz and siderite. The country rock in the Monarch mine is the Burke formation; the upper part of the Prichard formation, which underlies the Burke, is found near the portal of the 1400 level. The principal ore minerals are galena and sphalerite. Copper minerals, such as chalcopyrite, malachite, chrysocolla, and azurite, are common but not so abundant as galena and sphalerite. Veins containing 10 inches of solid galena and sphalerite have been mined. The principal gangue minerals are quartz and siderite.

BLACK HORSE AND PARAGON MINES

The Black Horse (pl. 61) and Paragon mines are both located in Paragon Gulch approximately 6.5 miles east of Murray. Accurate production figures for these mines are not available. Judging from the size of the stopes in the Black Horse mine, it probably had a fair production for a short time. The Paragon mines were inaccessible in 1953; therefore it was impossible to know what their stopes are like. Umpleby and Jones (1923, p. 103) state that the lower Paragon mine had a production before 1923 of about 30 cars of 40 to 50 percent zinc ore and a few cars of lead ore. It is very doubtful if the upper Paragon mine produced more than several tons of ore.

The Black Horse (Murray Hill) mine exposes a mineralized shear zone that strikes N. 55° to 65° W. and dips 65° to 75° SW. The shear zone is exposed on the lower level for about 500 feet and on the upper level for 200 feet. The dip distance from the upper level to the lower level is about 625 feet. Stopes having an average width of about 3 feet have been made on the southwest-plunging ore shoots between the middle and lower levels. The ore consists of sphalerite mainly and some galena in a gangue of quartz and carbonate minerals. In the lower level, 100 feet north of the main shear zone, another considerably weaker shear, which may possibly be a split from the main shear, is exposed. This weaker shear has some galena, pyrite, and sphalerite in a gangue of quartz and carbonate minerals. The enclosing rocks, of the lower part of the Prichard formation, strike N. 15° to 20° W. and dip steeply east, forming part of the east limb of the Trout Creek anticline.

The upper Paragon mine was inaccessible in the summer of 1953, but according to Ransome (Ransome and Calkins, 1908, p. 190) a 300-foot shaft that collars in the stream bottom follows a mineralized shear zone that strikes about N. 70° W. and dips 45° SW. The country rock includes both the upper and lower parts of the Prichard formation. The Prichard formation forms the eastern flank of Trout Creek anticline, strikes almost due north, and dips steeply to the east or is overturned to the west.

The inaccessible lower Paragon mine, often called the Chicago-London mine, is near the junction of Paragon Gulch and Prichard Creek. According to Umpleby and Jones (1923, p. 103), the mine has about 1,500 feet of drifts exposing a mineralized shear-zone type of vein that strikes N. 77° W. and dips 70° S. The ore minerals are sphalerite, galena, and pyrrhotite in a gangue of quartz and carbonate minerals. The enclosing country rock is the lower part of the Prichard formation which has a northerly strike, an easterly dip, and is also part of the east limb of the Trout Creek anticline.

BEAR TOP, IONE, AND OROFINO MINES

The Bear Top, Ione, and Orofino mines are on the south slope above Bear Gulch, a tributary to Prichard Creek, about 7 miles east of Murray. The country rock at these mines is the lower part of the Prichard formation, which forms part of the east flank of the Trout Creek anticline and here strikes almost due north and dips steeply to the east. Although these mines are close together and are close to the mines in Paragon Gulch, each of them has opened up a different but almost parallel mineralized shear zone.

At the Bear Top mine three levels expose the vein, which strikes N. 45° to 65° W. and has dips ranging from 60° S. to vertical. The level consists of a 2,235-foot crosscut to the vein and 500 feet of drift along the vein. The middle level is 420 feet vertically above the lower level; it consists of a 450-foot crosscut to the vein and about 400 feet of drift along the vein. The upper level is 605 feet vertically above the lower level; it has a 40-foot crosscut to the vein and a drift about 50 feet in length along the vein. Some stoping has been done between levels and above the upper level. The mineralized shear zone is offset on the middle level by a nearly north-striking fault that almost parallels the bedding and displaces the western part of the vein to the north—

a displacement that corresponds to apparent reverse faulting. The ore minerals are galena and some sphalerite and chalcopyrite in a gangue of quartz, pyrite, and carbonate minerals. The vein is reported to have had, in places, a seam of pure galena up to 10 inches thick. Production figures for the Bear Top mine are not available, but the mine has been worked periodically since about 1900.

At the Ione mine, two levels expose a mineralized shear zone striking N. 70° E. and dipping about 65° SE. The lower level has a 700-foot crosscut to the vein and about 50 feet of drift along the vein. The upper level is 147 feet vertically above the lower level, and its portal is in the gully to the west of the lower level portal. The upper level has a 250-foot crosscut to the vein and about 60 feet of drift along the vein. An inclined raise was driven on the vein from the lower level to the upper level. The mineralized shear zone is offset, the west side to the north, by a north-striking fault on the upper level; the displacement corresponds to apparent reverse faulting. The ore minerals are galena and a little sphalerite in a gangue of quartz and a carbonate mineral. The vein, as seen in the raise, ranges from about 3 to 10 inches in width. Production from the Ione mine has been very small to date; but some high-grade ore, mainly from the raise, has been carefully sorted on the dump. It has been reported that a small vein containing antimony has been found about 500 feet south of and almost parallel to the Ione shear zone.

The Orofino mine is directly down slope from the Ione mine, and its two levels expose a vein that strikes from N. 60° W. to N. 80° E. and dips 50° to 60° S. The lower level consists of a 950-foot crosscut to the vein and about 400 feet of drift along the vein. The upper level is about 197 feet vertically above the lower level; it consists of a 300-foot crosscut to the vein and about 150 feet of drift along the vein. Considerable stoping has been done between the two levels and above the upper level. Like the Bear Top and Ione shear zones, the Orofino shear zone is offset by a north-striking fault that parallels bedding and displaces the western part to the north; the displacement indicates reverse faulting. The ore minerals are galena and sphalerite in a gangue of quartz and a carbonate mineral. Production figures for the Orofino mine are not available, but, considering the size of the stopes, this mine was probably the largest producer in Bear Gulch.

SILVER STRIKE MINE

The Silver Strike mine is about 6 miles from Murray and about 2.5 miles up Granite Gulch, a tributary to Prichard Creek. Three main levels and one sublevel expose a vein which strikes N. 25° W. and dips 60° SW. The lower level has a crosscut 2,460 feet long to the vein and a drift that follows the vein for about 1,200 feet. The middle level, now inaccessible, is 175 feet above the lower level, has a crosscut about 1,000 feet long to the vein, and has a drift that follows the vein for about 1,000 feet. The upper level, partly accessible, is 225 feet above the middle level (400 feet above the lower level), has a 500-foot crosscut to the vein, and has a drift that follows along the vein for 600 feet. About 200 feet below the lower level a sublevel exposes the vein for about 350 feet. The country rock in the mine is predominantly quartzite and argillite of the lower part of the Prichard formation, which here strikes northerly and dips 30° to 60° W. About 1,000 feet in from the portal of the lower level a strong fault, which is believed to be a continuation of the O'Neill Gulch fault, is marked by a sheared and brecciated zone 40 feet wide. In the northern faces of both the lower and middle levels, monzonite that has a normal intrusive contact against the Prichard formation is exposed. Winzes, raises, and stopes have been made on the vein from the upper level down to the sublevel below the lower level. The vein ranges from several inches to 1 foot in thickness, and is reported to have contained, in places, 4 to 8 inches of solid galena. The ore minerals are galena and some sphalerite in a gangue of quartz, carbonate minerals, and some pyrite.

GIANT LEDGE PROSPECT

The Giant Ledge prospect is 4.5 miles east of Murray, about 1 mile up Granite Gulch. A 400-foot shaft, which collars at creek level, has been sunk; from the bottom of the shaft, 2,250 feet of drifting has exposed a fault between the monzonite and the Prichard formation. This fault, the French Gulch fault, strikes about N. 30° W. and dips 85° NE. The average trend of the bedding is about N. 10° W. and the dip is 75° NE., but near the fault zone the bedding is irregular and highly folded. No mineralized rock other than very small (up to half an inch wide) stringers of quartz containing specks of galena were found. No stopes have been developed, and there apparently has been no production.

OTHER MINES AND PROSPECTS

Many other mines and prospects are within the mapped area. A few—for example, the St. James, C and R, Snowshoe, Champion, Rooster Goose, A and M, and Highland-Aurora—are either partly or completely inaccessible. In other mines and prospects exploration has not gone far enough to reach the objectives sought or has disclosed only unproductive veins; examples of unproductive mines and prospects are the Rob Roy, Giant, Liberty, Vendetta, St. Peter, Potosi, Currency, and Consolidated Silver-Lead.

At the Currency mine, about 400 feet in from the portal, a drift 600 feet long follows a mineralized shear zone that strikes N. 45° W. and dips from 60° to 85° NE. The vein ranges from a thin film to 5 or 6 feet in width; in places it consists entirely of quartz and a carbonate mineral and contains no ore minerals. Some diamond drilling has been done to test this vein at depth, but the results were not favorable.

At the Consolidated Silver-Lead mine a drift, about 1,400 feet in from the portal of the lower level, has been driven along a mineralized shear zone for about 1,100 feet. The vein is about 1,200 feet northeast of, and parallel to, the Jack Waite vein. It is almost vertical (much steeper than the Jack Waite vein) and is composed of 3 to 5 feet of quartz, a carbonate mineral, and some pyrite and specks of galena. The upper level intersects the vein, and a 200-foot raise connects the lower level with the upper level.

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