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MINES AND MINERAL DEPOSITS

(EXCEPT FUELS)

SANDERS COUNTY, MONTANA

By
F. A. CROWLEY

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ABSTRACT

Sanders County is perched on the western edge of Montana as though it were ready to jump into Idaho. It is rimmed by two mountain ranges, and is bisected by the Clark Fork of the Columbia River. The Belt Series of metasediments underlies the greater portion of the county, but younger intrusives are present. Since the time of record keeping the county is credited with a mines production of almost 13 million dollars in metals, most of which is silver, copper, lead, and zinc. Mineralization is not only diverse in mode of occurrence, but is also spread throughout different rock types. However, most metallization has taken place near secondary faults in rocks of a brittle nature. Described are 13 mining districts and 41 of the most important mining properties. Historical information is included for a number of little-known prospects and mines. Production records for districts and individual mines are presented along with underground and surface geological maps of many properties.

INTRODUCTION

Sanders County is one of the westernmost counties in Montana. It is framed on the southwest by the crestline of the northern Bitterroot Range or, as it is sometimes called, Coeur d'Alene Range, and on the northeast by the jagged ridges of the Cabinet Mountains. It is sliced down the middle for most of its length by the Clark Fork of the Columbia River. The County is both a political and a geographical unit; however, geologically it is one small island in a vast sea of Beltian rocks that cover much of northwestern Montana, western Idaho, and part of southern Alberta.

The County's mineral potential and the mode of occurrence of its mineral resources are, in general, known. The general geology and a few mining properties were described by Calkins and MacDonald (1909). Earlier, Lindgren (1904) made a geological reconnaissance across parts of the Bitterroot Mountains. The far western part of the County has been described by Gibson (1948), Gibson, Jenks, and Campbell (1941), and Jenks (1938). Lyden (1948) reported on the gold placers along the Clark Fork, Trout Creek, Prospect Creek, and Vermilion River, while Anderson (1930), O'Leary (1907), Rowe (1911), and Turner (1931) described individual mining properties in the County.

Even though these and other investigators have contributed much in the knowledge of the County's geology and mineral resources, many of the properties listed herein are described for the first time. The purpose of this bulletin is to co-ordinate and bring together in one publication the many and scattered works of early investigators, and to update and supplement the earlier descriptions by field examination.

ABBREVIATIONS USED

The following abbreviations are used on illustrations within this report:

Alas—alaskite
alt—altered
Arg—argillite
Az—azurite
blk—black
Chry—chrysocolla
Cpy—chalcopyrite
cr—crushed
Cu—copper
dia—diabase
dk—dark
FeOx—iron oxide
flt—fault
fn—fine
fw—footwall
frac—fractured
frag—fragments
Gal—galena
g—gouge
gry—grey
lt—light
med—medium
Mn—manganese
$MnCO_3$—manganese carbonate
//—parallel
Py—pyrite
Qtz—quartz
qtzite—quartzite
rk—rock
Rs—raise
sec—section
sep—separated
shrd—sheared
Sid—siderite
sm—small
Stb—stibnite
stn—stain
strgs—stringers
stpd—stoped
sul—sulfides
trav—traverse
U—underhand
V—very
ver—vertical
vn—vein
w/—with
wt—white
ZnS—zinc sulfide
+—abundant
— —sparse

SOURCES OF INFORMATION

During the summers of 1960 and 1961 the author examined most of the mining properties in this report. Where possible, underground maps were made by Brunton and tape surveys, and samples were taken for mineralogical studies and chemical analyses.

The geochemical analyses were made by the geochemical prospecting class of Fred N. Earll, Head of the Geology Department, Montana School of Mines, and by Don C. Lawson, Bureau laboratory technician. Chemical analyses were made by Clem J. Bartzen and by the analytical laboratory of The Anaconda Co.

The large task of compiling a historical summary on mining, canvassing mineral producers for permission to publish production records, and the preparation of the production statistics was done by Betty J. Thornton, editorial clerk, and Evelyn M. Whitaker and Ruth Coon, statistical clerks, of the Albany, (Oregon) Office of Minerals Resources, Region 1, Bureau of Mines, U. S. Department of the Interior.

The reports consulted during the preparation of this publication are listed under "References," and subject matter used is noted throughout the text.

ACKNOWLEDGMENTS

Without the help of numerous persons a report such as this could not be completed. To many unnamed persons who gave directions or passed the author on to better sources of information, the writer is indebted.

With a sincere feeling of gratitude the author would like to acknowledge the help given by the following persons: John M. Guilbert, Lester G. Zeihen, and Laszlo Dudas, all of The Anaconda Co., aided greatly in solving mineralogical problems; Earl F. Elstone, Mrs. Lillian Peterson, and Knute Kirkeberg placed at the disposal of the writer reports and maps on their respective mines; Jack E. Hall, Marion Schmoyer, Ralph T. Talarico, Elmer Allen, Austin Monk, Joe C. Brooks, and Wesley Stearns guided the writer to various mining properties; Mr. and Mrs. Wendell E. Stephens and Mrs. Kristine Kirkeberg gave graciously of their hospitability and knowledge of mining activities; and Joe E. Green provided much historical information. Robert D. Newman and Don C. Lawson efficiently aided the author in the field, and Roger B. Holmes prepared the illustrations.

GEOGRAPHY

Named after U. S. Senator Wilbur F. Sanders, a pioneer, vigilante, and statesman, Sanders County was created February 7, 1905, from part of Missoula County. The County embraces an area of 2,819 square miles, 8 square miles of which is designated as water area. A cross section from southwest to northeast through almost any part would be V-shaped. The point of the V is the Clark Fork River, or the Flathead River, and the vertices are the crest lines of the northern Bitterroot Range (Coeur d'Alene Mountains) to the southwest and the Cabinet Mountains to the northeast. Thus, it is a long narrow County enclosing, for most of its length, the drainage systems of small tributaries of the Clark Fork River and a short portion of the Flathead River. (See fig. 1.)

Centers of population are aligned along the main transportation routes, which traverse the two major river valleys. U. S. Highway 10-A traverses the County from end to end; it is paralleled by the Northern Pacific Railroad. Many side roads along the smaller tributary streams are rough dirt roads, but those following the major tributary streams are usually graveled, or in some cases are surfaced with blacktop.

An active logging industry thrives on the heavy stands of white pine, larch, and Douglas fir. In 1956 about 82 million board feet of lumber were produced. Because most of the land is so heavily forested, the Federal Government controls 61.3 percent of the land as National Forest.

The bulk of the County's approximately 8,000 people live in rural areas and are engaged in livestock ranching, which is the principal industry. More than three-fourths of the total farm income is derived from livestock and livestock products.

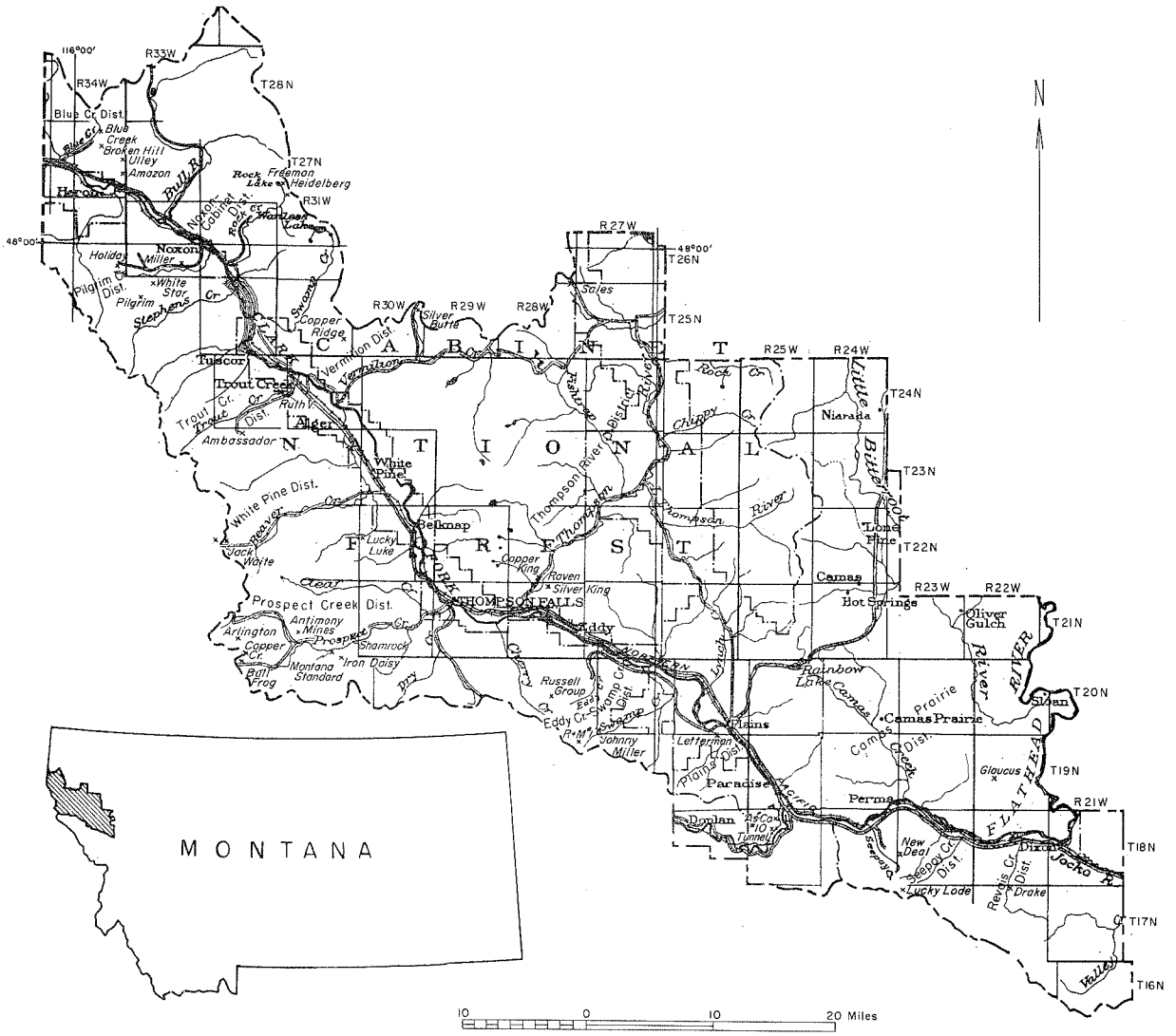

FIGURE 1.—Map of Sanders County showing mines and mining districts.

Climate is generally mild along the river bottom throughout the year. Sanders County lies within the only major area in the State where the January temperature averages over 24 degrees Fahrenheit. Average July temperature is between 60 and 68 degrees. Precipitation is generally high as compared with the rest of the State. Along the Bitterroot Mountains the average annual precipitation is over 35 inches. Along the eastern part of the County and in the Cabinet Mountains the average is 25 to 35 inches. Greatest amount of precipitation falls during May and June, which corresponds to the Clark Fork's high monthly runoff of 2,000,000 acre-feet of water. Lowest precipitation figures are recorded January through April.

The agricultural industry employs the greatest number of the County's labor force, followed by lumbering and manufacturing, services and financing, trades, construction, public administration, forestry, and fisheries. The mining industry employs the least number, which in 1960 was 9 out of a total labor force of 2,592.

PHYSIOGRAPHY

Sanders County along with the rest of western Montana is included in the Rocky Mountain physiographic province, a province characterized by mountains and intermontane valleys or basins.

Two ranges dominate the County—the Cabinet Mountains and the Bitterroot Range. Along the northern portion of the Cabinet Mountains is a spectacular series of glacially sculptured ridges and alpine scenery. From an elevation of about 2,300 feet along the Clark Fork River the jagged peaks of the range rise to elevations of 7,500 to 8,700 feet above sea level. Incised streams, draining high glacial cirques and scoured valleys, enter the Clark Fork River along the southwest boundary of the range. With the exception of the deep notch along the Bull

River Valley, the Cabinet Mountains are uniformly higher and more rugged than the surrounding mountains. Southeast of Vermilion River the Cabinet Mountains assume a rounded, more subdued topography similar to that of the Bitterroot Range. To the east the range is a series of low rolling hills.

The Bitterroot Range along the southern edge of the County is dominantly a series of even-crested, rounded ridges displaying few effects of glaciation, except at the head of Stephens Creek south of Noxon, along the divide at the head of Prospect Creek, and south of Eddy at the head of Eddy Creek. Nevertheless, many of the streams occupy steep-sided canyons of great relief. Ridge crestlines are generally between 5,000 and 6,000 feet above sea level.

The Clark Fork of the Columbia flows through the often gorgelike valley between the two ranges. After cutting across the Ritterroot Range between St. Regis and Paradise, the Clark Fork is joined by the Flathead River a few miles east of Paradise. The two rivers drain most of Montana west of the Continental Divide and as one river, the Clark Fork, have an average annual runoff of 15,000,000 acre-feet of water.

Sanders County can be likened to a person whose childhood was eventful, whose middle age was wasted, and whose predominate characteristics were shaped late in life. Its early life, over 600 million years ago, was that of a shallow sea wherein many thousands of feet of sandy, shaly, and limy sediments were deposited. These sediments are known today as the Belt Series. During the Precambrian, basic sills were intruded between sedimentary beds. Paleozoic sediments were laid down over the somewhat distorted Belt, but the only record not destroyed by erosion is a small patch of Cambrian shale and limestone near Heron.

During the Mesozoic Era about 135 million years ago, granitic bodies were intruded into the folded and uplifted Belt Series. Then came the shaping of the County's later life—the shaping and molding by stream and glacial erosion.

GLACIATION

This period of the geologic history of Sanders County has been aptly described by Alden (1953). The physiographic history of western Montana indicates that during late Tertiary the land surface of Sanders County was similar to that of today, but the stream channels were probably at higher elevations and the relief more subdued.

In eastern Idaho during the middle or upper Miocene age the Columbia River basalt flows blocked the westward flow of waters, and in Idaho a thick fossiliferous formation, the Latah, was deposited. From relative elevations of the rim of basalt (2,500 feet above sea level), it could be inferred that waters were backed up into Montana as far as Thompson Falls or Plains. But the evidence of such water-laid sediments cannot be found in Sanders County.

While evidence of sedimentation is lacking, other physical features point to the existence of stable, sometimes broad, valleys in Sanders County during Pliocene and early Pleistocene epochs. The physiography and glacial geology map (Pl. 1A, in pocket) shows several areas of "QT," one north of Plains and one near the confluence of Thompson River and Little Thompson River, which are remnants of high bench gravels formed in a Pliocene (?) valley bottom at an elevation of about 3,500 feet above sea level.

A rising of the land mass again caused downcutting and the eventual formation of lower and somewhat stable valleys. Remnants of medial benches ("QT" on Pl. 1A) can be seen at the mouths of Swamp Creek, Thompson River, Bull River, northwest of Trout Creek, and along the Vermilion and Thompson Rivers. Near Belknap and White Pine several other bench levels have been described (Alden, 1953, p. 52-55).

During the Illinoian or early Wisconsin Stage of Pleistocene glaciation a lobe of the great Flathead glacier moved down the Flathead Valley and through the gap now occupied by the Flathead River north of Dixon. Glacial till overlain by silt from Lake Missoula has been found near and a few miles west of Dixon, and glacial striae on bedrock has been observed west of the Flathead River near Moiese (Alden, 1953, p. 89).

After the ominous beginnings of small glaciers a massive sheet of ice, the Cordilleran ice sheet, moved across northwestern Montana. Not once, but several times the ice advanced, flowing southward. Sanders County was not overridden by the main ice mass, but at different times glacial lobes, probably fed by tributary mountain glaciers, advanced down the Bull Lake trough. Other tongues of ice lapped across the County line near the head of Thompson River.

Most spectacular of all was the great wall of ice that moved down the Purcell trench in Idaho. A lobe of this ice moved up the Clark Fork Valley to the Montana-Idaho line and formed a 2,000-foot high dam.

This wall of ice, the top of which was about 4,500 feet above sea level, dammed the river forming Glacial Lake Missoula. (See Pl. 1A.) Water backed up the Clark Fork River nearly as far as Drummond in Granite County and up the Bitterroot River as far as Darby. All of the valleys in Sanders County were inundated. Camas Prairie Basin, Thompson River, and Prospect Creek were large arms of the lake. Fine silt and sand deposited in the bottom of the lake can be seen along the Clark Fork and Flathead Valleys in Sanders County. Glacial erratics (ice-rafted boulders) can be seen in many places. One easily noticed erratic lies adjacent to U. S. Highway 10-A, 4.1 miles east of Perma.

It is believed that Lake Missoula was drained by the recession of the ice sheet and then was rejuvenated one or more times by renewed ice advances (Alden, 1953, p. 155). During the inundation tributaries to the lake washed material from their headwaters and built up deltas of sand, gravel, and rock where the streams entered the lake. Many of these gulch fillings are preserved along the north side of the Clark Fork River between Plains and Perma.

After the final retreat of the Cordilleran ice sheet the Clark Fork and Flathead Rivers and their tributaries again began their ceaseless erosion. During recent time they have cut their way down through the glacial silts and clays, and in places, as at Eddy narrows, have reached bedrock.

GENERAL GEOLOGY

SEDIMENTARY ROCKS

PRICHARD FORMATION (PRE-RAVALLI GROUP)

The lowest recognizable unit in the Belt Series is the Prichard Formation (Pl. 1B, in pocket) of the Pre-Ravalli Group, one of the terms proposed by C. P. Ross of the U. S. Geological Survey to facilitate regional correlation of the many-named groups of the Belt Series. The Prichard is dominantly composed of light-grey to medium-grey to black argillite with interbeds of light-colored sandstone and quartzite. The base of the Prichard has not been found in Sanders County, north in Lincoln County, nor at the type locality along Prichard Creek in the Coeur d'Alene district.

Although the full section of Prichard has not been measured in western Montana, it has been estimated to be at least 7,800 feet thick in the Trout Creek area (Jenks, 1938, p. 30). Gibson (1948, p. 10) reports at least 9,700 feet of the rusty-brown weathering Prichard argillites in the Libby quadrangle, and Ransome and Calkins (1908, p. 29) estimate 8,000 feet as the thickness in the Coeur d'Alene's. In the southern half of the Yaak River quadrangle in Lincoln County, Johns (1959, p. 8) reports 9,000 feet of Prichard with the base not exposed. Incomplete sections measured by Johns (1961, p. 11) in the Ural and northern Yaak quadrangles revealed 12,000+ feet of Prichard, but just north of the Thompson River in the Thompson Lakes quadrangle, Johns (1960, p. 13) measured only 6,000 feet of Prichard (base not exposed). Just west of Sanders County in the Clark Fork district of Idaho, Anderson (1930, p. 14) reports 20,000+ feet of Prichard. This apparent thickening to the west has led some to state that the formation does do just that. However, Wallace and Hosterman (1956, p. 597) have shown that at least 17,000 feet of Prichard is exposed along the Clark Fork River south of the junction of the Clark Fork and Flathead Rivers. The very fact that the base of the Prichard has never been found in any of these measured sections leads one to believe that the correct nature of the formation, as far as thinning or thickening is concerned, is not known.

Distinctive lithologic change was not noted through Sanders County where the Prichard corresponds closely to the lithology of the type locality, which incidentally, is just slightly south of the Prospect Creek district. Everywhere the brownish-weathering formation is thin bedded, banded, and in places is quite slaty, but the slaty cleavage is less noticeable in the Trout Creek and Libby quadrangles than it is in the Coeur d'Alenes. However, slaty cleavage near the top of the formation is prominent along the Clark Fork River south of Paradise (Wallace and Hosterman, 1956, p. 581).

According to Calkins (1941, p. 368), the Prichard is somewhat calcareous in the Libby and Trout Creek quadrangles, but this was not noticed by the writer at the places mentioned nor in the massive exposures in the eastern part of the County. At the type locality in Idaho argillaceous layers predominate over quartzite layers, but to the northwest Anderson reports an increasing silica content, while Wallace and Hosterman (1956, p. 579) also record fewer argillite beds, more silica and, in general, thicker beds along the Clark Fork section.

In many places the argillites are sericite-rich or as at the R & M #1 prospect on Swamp Creek, the thin-banded quartzitic argillites are speckled with biotite. Pyrite and to a lesser extent pyrrhotite are found throughout the formation, and most likely account for the iron-stained appearance of the weathered rock. Highly weathered rock often contains casts of limonite after pyrite, and cubic voids left in the shaly layers by the solution of pyrite may be as wide as one-half inch.

Even though the Prichard does change slightly from locality to locality, it still remains, to this writer at least, to be the most easily recognized formation in the County because of its predominantly thin-bedded and banded argillaceous nature and its somber colors.

RAVALLI GROUP

Overlying the massive Prichard Series of argillaceous sediments is the predominantly siliceous Ravalli Group. (See Pl. 1B.) Where first termed the Ravalli Series in the Mission Range, the group is composed of 8,255 feet of sandstones and quartzitic sandstones with minor shaly members. From bottom to top the "series" is described as 4,645 feet of greenish-grey fine-grained quartzitic sandstones, 1,060 feet of compact grey sandstones, and 2,550 feet of purplish-grey and grey fine-grained sandstones (Walcott, 1906, p. 7).

Extensive work by Ransome and Calkins (1908) in the Coeur d'Alene district resulted in the separation of the Ravalli Group into three formations, the Burke, Revett, and St. Regis.

The Burke Formation, well exposed near the town of Burke, Idaho, is a 2,000-foot series of whitish - to greenish - grey quartzite which becomes more shaly and darker colored near its lower contact with the Prichard. It grades into the Prichard near the ill-defined contact. Shallow-water features are common.

Resting conformably on top of the Burke is white thick-bedded quartzite of the Revett Formation. Ransome and Calkins (1908, p. 35) report about 1,200 feet of erosion-resistant Revett in the Coeur d'Alene district, which was measured near Revett Lake just west of the head of Glidden Creek (western Prospect Creek district). Because of its resistance to erosion the Revett often caps high peaks whose slopes are covered with blocky quartzite talus.

Along the headwaters of the St. Regis River in Idaho, the top of the Ravalli Group is well exposed. Here the St. Regis Formation is composed of about 1,000 feet of green and purple indurated shales and sandstones, which display mud cracks and ripple marks attesting to their shallow-water deposition. Also resistant to erosion, the predominantly siliceous formation forms steep cliffs and caps high ridges.

As might be expected, the Ravalli Group along the southern half of Sanders County displays lithologic features similar to those in the adjacent Coeur d'Alene district, but as one approaches the Clark Fork River some of the distinctive characteristics disappear. Thus, in the northern part of the Trout Creek quadrangle and in the Libby quadrangle the three formations could not be separated and the system of quartzitic sediments between the Wallace, on top, and the Prichard, on the bottom, could only be designated as the Ravalli Group. Throughout much of Sanders County the Ravalli is a thick, almost inseparable, series of white to light-grey quartzites and sandy argillites.

Thickness of the Ravalli Group differs considerably throughout the most-studied areas in and around Sanders County. Measured thickness in feet are as follows: Coeur d'Alene, 4,200; Trout Creek, 9,500; Libby, 10,000; South Yaak River, 12,000; Thompson Lakes, 11,000; Ural and North Yaak River, 7,000; Western Mineral County, about 4,300; and Mission Range, 8,200. Therefore, from south to north the Ravalli Group thickens, but to the far north its thickness decreases.

Good exposures of blocky white cross-bedded quartzite can be seen on Squaw Peak northwest of Noxon, near Rock Lake, at the Raven mine, on Thompson River, and at the Drake mine on Revais Creek. However, at the Blue Creek mine quartzite beds in the Ravalli are almost black.

WALLACE FORMATION (PIEGAN GROUP)

The very heterogeneous, but predominantly calcareous Wallace Formation of the Piegan Group is a thick series of argillites and sandstones with the most common rock fitting the intermediate description of a sandy argillite. Some beds of impure limestone and dolomite are present. Calcareous and dolomitic for its most part, almost all rocks of the Wallace effervesce with cold dilute hydrochloric acid. Although the dominant colors are shades of green, many grey tones can be seen throughout the diverse rock types and in some parts of the Libby quadrangle near the top of the formation reddish colors are conspicuous. Because it is ferruginous, the formation weathers to shades of brown (Gibson, 1948, p. 14, 15).

In Sanders County and in the sourrounding areas, the Wallace Formation decreases in thickness from north to south, but like the Ravalli Group, thins again to the far north. In the Ural and North Yaak River quadrangles the Wallace is 8,000 feet thick (Johns, 1961, p. 11). Southward in the southern Yaak River and Thompson Lakes quadrangles it is 14,500 and 13,000 feet thick, respectively (Johns, 1959, p. 9 and 1960, p. 13). From north to south through the Libby quadrangle, Gibson (1948, p. 13) reports 16,000 and 11,200 feet of Wallace while in the Trout Creek quadrangle, north to south, the thickness decreases from 10,000 to 7,000 feet. The thickness in the Coeur d'Alene district is about 4,000 feet (Ransome and Calkins, 1908, p. 40), and in western Mineral County, 6,500 feet of Wallace was measured (Wallace and Hosterman, 1956, p. 584).

Features of shallow-water deposition, ripple marks and mud cracks, are very abundant throughout the Wallace, and primitive fossil algae are preserved in some beds. The algal beds are common in the Wallace, but are also present in the overlying Striped Peak Formation. The calcareous nature of the formation and presence of algal beds are aids in distinguishing the Wallace. However, the most diagnostic feature is molar tooth structure, which resembles the grinding surface of an elephant's molar. The structure appears on weathered surfaces as small wrinkled ridges and depressions. The ridges, being composed of more resistant material, stand about one-sixteenth of an inch above the depressions. The depressions appear to contain a greater percentage of calcite which is less resistant to erosion and solution.

In areal distribution, the Wallace is prominantly exposed through the Trout Creek and Libby quadrangles and along the Thompson River and head of Vermilion River. (See Pl. 1B.) Throughout these areas the most noticeable rock is a grey to green calcareous sandy argillite. The Wallace is the host rock at the Holliday mine and at other prospects along Pilgrim Creek and at the

Lucky Luke in the White Pine district. There are no outcrops of the Wallace east of Plains in Sanders County.

MISSOULA GROUP

The uppermost part of the Belt Series in Sanders County is the Missoula Group. Because its outcrop areas are generally off the beaten path, the Missoula Group is not well known in the County. All of the exposures, as shown on plate 1B, are west of Belknap; however, numerous outcrops can be seen along Fishtrap Creek, a tributary of the Thompson River (not shown on map). Several small patches of the Missoula Group outcrop near White Pine and west of the mouth of the Vermilion River. (See Pl. 1B.) Others are south of Noxon where it forms the center of the Trout Creek syncline and just west of Mt. Berray where it occupies the trough of a syncline. It also outcrops as a narrow strip along the Montana-Idaho border south of Heron. Deep-red ripple-marked argillites much like the base of the Missoula Group were also noticed near Image Lake at the head of the Vermilion River.

The terminology of the sedimentary layers above the Piegan Group is somewhat confusing. Rapid changes in lithology, horizontally and vertically, have resulted in many formational names throughout western Montana. In the Coeur d'Alenes an incomplete section (1,000 feet) of thin-bedded reddish-purple and green shales and sandstones was measured. Here it was termed the Striped Peak. Jenks (1938, p. 55) carried the name northward into the Trout Creek quadrangle and measured 3,700 feet (top not exposed) of the lower Striped Peak. It consisted of impure quartzite, sandstone, and shale with colors predominantly of deep red, light pink, purplish grey, and lavender with some green beds. North of the Clark Fork River in the Libby quadrangle, Gibson (1948, p. 16) reports a maximum thickness of 2,500 feet near Mt. Berray. Dominant rocks are dark-red to purplish sandstone and quartzite. Algal dolomites are reported in the Mt. Berray section. Above the Striped Peak, Gibson (1948, p. 17, 18) has termed a thick series of light- to dark-grey and greenish-grey argillite, the Libby Formation. Although the top is eroded, 6,000 feet of this formation was measured along the Kootenai River. Johns (1959, p. 13, 14 and 1960, p. 12-14) carried the formational names Striped Peak and Libby northward through the Yaak River and Thompson Lakes quadrangles, but included both in the Missoula Group. In the Ural and North Yaak River quadrangles Johns (1961, p. 17 and 18) correlated rocks above the Purcell Basalt with the Gateway Formation west of the Kootenai River and with the Shepard and Kintla east of the Kootenai River.

For the purposes of this report the term Missoula Group, as proposed by C. P. Ross, or the term Striped Peak, will be sufficient for any descriptive purposes. Perhaps it would even be better to abandon the group terminology in the County as long as only one formation, the Striped Peak, can be recognized.

No mines or prospects are known within the Striped Peak.

CAMBRIAN SEDIMENTS

Along the north bank of the Clark Fork River 5.9 miles west of the Bull River bridge on U. S. Highway 10-A, there are two small outcrops of Cambrian rock. The outcrops consist of black shale and light-grey limestone; the shale contains fragments of trilobites, and the limestone beds contain a few brachiopods.

Although the exact physical relation of the Cambrian rocks to the adjacent Belt sediments is obscure because of a covering of glacial gravels, the Cambrian is believed to represent a down-faulted wedge along the Hope fault.

Based on fossil evidence the beds have been classified as Middle Cambrian (Gibson, 1948, p. 19, 20).

Middle Cambrian fossils also have been found in a shale unit exposed in a logging road cut between Beatrice Creek and the West Fork of Fishtrap Creek by geologists of the Northern Pacific Railway* in 1962. The fossils occur in a band of unquestionably lower Paleozoic sedimentary rocks which extend from near Thompson River northwestward for several miles. The band overlies the Libby Formation with apparent conformity. The lowest member is a 25-foot quartzitic sandstone on which two buidling stone quarries have been opened. (See Figure 2.) Above

* James Keim & E. Thurlow, Northern Pacific Railway Company, personal communication to editor.

FIGURE 2.—Rock trimmer and palletted building stone at McDonald quarry on Fishtrap Creek. Quarry face in background.

the sandstone is a 2-foot shale band in which the fossils were found, and above this, a thick sequence of dolomitic limestone.

This occurrence of Paleozoic rocks has been described in a Northern Pacific report which is being submitted (1963) for publication in a technical journal.

IGNEOUS ROCKS

BASIC INTRUSIVES

The lower three units of the Belt Series, Prichard Formation, Ravalli Group, and Wallace Formation, all contain basic sills and dikes believed to be Precambrian in age. Gibson (1948, p. 20-24) calls them metadiorite in the Libby quadrangle whereas in other areas, in the eastern part of the County, the sills are gabbroic in composition. The composition and physical appearance differ considerably within the diorite-gabbro compositional range. Even within a single outcrop differences in physical appearance are noticeable. Medium-grained diorite is the predominant rock, but porphyritic phases are usually present.

In the Libby quadrangle Gibson (1948, p. 21) reports that about 14 percent of the total number of sills are in the Prichard, 16 percent in the Ravalli, and 70 percent in the Wallace. However, the greatest thickness of sill material is in the Prichard. Thus in eastern Sanders County the sills appear to be more numerous because of the large areas underlain by the Prichard Formation. Here some of the sills are almost a mile in width, and are, therefore, of sufficient size to be shown on the geologic map. (See pl. 1B.) In other formations many of the basic intrusives are too narrow to be shown.

The predominant rock in the Precambrian sills is a black to greenish-black medium-grained diorite. Gibson calls them metadiorite because of evidence in the Libby quadrangle, in the Clark Fork district, and in Canada which points to mineralogic changes caused by regional and hydrothermal metamorphism. It is believed that the alteration took place as amphibolization with hornblende, the most abundant mineral, replacing a formerly existing pyroxene. Augite partially replaced by hornblende has been noted by Gibson (1948, p. 22).

Plagioclase, ranging in composition from albite to andesine, is the second most abundant mineral. In some specimens two kinds of feldspar have been noticed. Sills that are little altered contain oligoclase or andesine, and in altered sills the feldspar is albite. Sills intermediate in alteration may contain both albite and/or andesine (Gibson, 1948, p. 23).

Other constituents are quartz, biotite, chlorite, sericite, epidote, and clinozoisite, with the accessory minerals orthoclase, sphene, rutile, leucoxene, apatite, magnetite, ilmenite, tourmaline, and zircon. Near mineralized areas the hornblende is attacked and replaced principally by chlorite and less so by carbonate, epidote, biotite, magnetite, and albite (Gibson, 1938, p. 309).

Mineralization is relatively common in and near the dark-colored intrusives. Ore bodies at the Montana Standard, Montana Premier, Drake, Ambassador, New Deal, and at the prospects on Eddy Creek are either in or adjacent to the basic dikes and sills. Many ore bodies in nearby areas are also associated with basic dikes. A notable example is the Snowstorm mine in Lincoln County.

ACID INTRUSIVES

In the western half of Sanders County there are a number of small light-colored granitic stocks believed to be Mesozoic in age. (See Pl. 1B.) The largest is the Dry Creek stock, a very small part of which extends into Sanders County. The bulk of the intrusive body is in Lincoln County east of Bull Lake. The stock is a very light-grey, massive, medium-grained quartz monzonite composed dominantly of feldspar and quartz with lesser amounts of apatite, zircon, magnetite, allanite, sphene, tourmaline, and pyrite. Minor variations in composition are present; of these granodiorite is the most prominent. Wallace Formation rocks surround the stock on all sides except at the western contact where the Bull Lake fault has dropped the Libby Formation into contact with the quartz monzonite (Gibson, 1948, p. 24-28).

On Hayes Ridge between the East Fork and North Branch of the East Fork of Bull River a small muscovite-bearing quartz monzonite has been intruded into the Ravalli Formation (Gibson, 1948, p. 29).

On Granite Creek, a tributary of Trout Creek, a small stock and several dikes of coarse-grained granitic rock have been intruded into the Prichard Formation. Rock on the dump of the Ambassador mine and boulders along Granite Creek are monzonite composed of plagioclase, orthoclase or microcline, biotite, and hornblende with minor amounts of quartz. Some specimens are mottled pink and grey; others are grey. The pink color is due to large orthoclase phenocrysts —some as long as one-half inch; the grey monzonite contains microcline instead of pink orthoclase.

At the mouth of Vermilion River a predominantly syenitic mass, the Twenty-Odd stock, has intruded the Ravalli Formation. The syenite is variable in composition but is composed mainly of orthoclase along with lesser amounts of sodic plagioclase and minor amounts of quartz, aegirine-augite, and titanite. Hornblende and biotite are present in most specimens, and the quartz content appears to be variable (Calkins and MacDonald, 1909, p. 46).

Two syenite sills on Beaver Creek have been reported by Jenks (1938, p. 192). Both are about

60 feet thick and are composed of orthoclase and albite phenocrysts in a feldspar-rich ground mass. The general composition is said to be similar to that of the Twenty-Odd stock.

STRUCTURE

The major structural features in Sanders County are folds and faults. Broad anticlines and synclines trend north to northwest and usually plunge in the same direction. Across the western part of the County the folds have tilted the strata to steep dips, but to the east the folds are gentler and in general the strata dip less steeply. Also to the west younger formations predominate being elevated by folding and faulting to form high ridges. To the east the older Prichard Formation rocks predominate and underlie low-level hills.

Of great economic importance are the major

TABLE 1.—Production of gold, silver, copper, lead, and zinc in terms of recoverable metals, 1906-61, Sanders County, Mont. (County created February 7, 1905.)

Year	Ore Tons	Gold Oz.	Silver Oz.	Copper Lb.	Lead Lb.	Zinc Lb.	Total Value
1906	14	28	—	—	—	—	$ 583
1907	No production						
1908[2]	303	20	184	1,144	165	—	678
1909[2]	29	1	388	2,000	5,294	—	708
1910[2]	466	46	5,641	36,738	72,229	—	11,835
1911[1] [2]	383	15	2,364	16,084	324,802	—	18,184
1912[1] [2]	1,297	36	11,819	52,329	708,056	—	48,502
1913[2]	1,240	111	17,009	84,732	310,772	—	39,365
1914[2]	122	3	3,547	18,287	58,682	—	6,750
1915[2]	245	13	3,273	37,607	34,311	—	10,117
1916[1] [2]	578	17	8,696	86,498	136,049	—	36,751
1917[1] [2]	2,648	42	17,480	80,115	1,490,829	—	165,365
1918[1] [2]	694	11	6,410	36,824	182,843	—	28,721
1919[1]	236	9	1,795	15,853	117,424	—	11,365
1920[1]	391	5	2,394	13,562	365,912	—	34,476
1921	53	[3]	1,229	3,233	3,317	—	1,804
1922[1]	121	4	1,883	12,774	80,504	—	8,112
1923[1]	283	2	3,194	17,622	273,634	—	24,403
1924	33	—	1,153	834	26,554	—	3,006
1925	175	11	3,166	21,960	36,449	62,832	13,485
1926[1]	7,702	2	6,304	13,366	1,117,548	105,196	103,138
1927[1]	20,429	—	10,384	4,783	2,361,808	8,604	155,860
1928[1]	20,326	53	11,984	9,176	2,051,219	790,000	176,592
1929[1]	34,140	78	19,810	25,903	4,360,831	525,000	326,104
1930[1]	33,882	111	25,836	39,814	6,044,604	85,134	323,728
1931[1]	74,244	220	48,586	83,049	9,873,566	854,898	424,003
1932[1]	9,038	123	8,408	115,079	1,568,667	56,367	60,919
1933[1]	14,750	61	15,903	18,265	3,235,784	204,310	136,317
1934	28,800	108	27,225	25,225	5,119,946	763,163	245,641
1935	11,229	33	9,543	26,289	2,241,675	230,068	109,993
1936[1]	37,530	85	30,785	59,685	6,941,826	1,590,540	431,146
1937[1]	51,272	175	43,161	158,000	10,514,000	1,392,400	769,460
1938[1]	52,746	92	41,792	48,990	10,145,696	1,307,417	564,496
1939[1]	48,141	157	34,644	192,528	8,434,405	1,019,346	498,457
1940[1]	45,391	324	38,205	279,000	8,470,700	851,460	547,212
1941	29,889	206	33,525	111,000	6,589,600	2,095,000	576,880
1942	24,274	126	20,219	23,000	3,997,600	696,000	354,138
1943	19,082	41	15,570	48,800	3,160,400	512,500	311,231
1944	10,189	28	10,800	59,000	2,256,100	183,500	218,032
1945	5,447	88	6,390	111,800	1,197,500	207,000	149,507
1946	4,967	275	5,172	182,700	938,000	170,500	166,445
1947	4,774	204	5,157	222,300	786,000	253,800	200,861
1948	4,841	119	7,509	163,800	1,204,500	252,200	295,655
1949	6,004	29	10,037	32,500	2,058,700	308,300	380,005
1950	7,206	19	9,100	14,300	2,029,400	353,900	336,098
1951	7,325	19	6,993	18,000	1,450,000	548,000	361,936
1952	9,451	21	7,707	20,000	1,466,000	882,000	394,988
1953	8,951	37	11,954	26,000	2,358,000	888,000	430,594
1954	10,260	23	14,574	36,000	2,336,000	970,000	449,407
1955	7,108	17	11,016	26,000	1,530,000	552,000	316,129
1956	8,629	26	14,117	32,000	2,516,000	838,000	537,105
1957	11,083	33	20,614	78,000	3,570,000	820,000	648,920
1958	9,480	24	14,974	94,000	2,818,000	268,000	396,156
1959	13,682	26	20,956	84,000	3,980,000	234,000	530,274
1960	5,398	28	9,737	20,000	1,998,000	260,000	283,518
1961	1,734	3	6,467	30,000	542,000	152,000	88,390
Total	7,308,705	1,388	726,783	3,070,548	135,491,901	2,129,435	$12,763,545

1—Includes production from the Jack Waite mine which was credited to the Eagle district, Shoshone County, Ida.
2—Includes production from Spring Gulch district, Mineral County, Mont.
3—Gold production was less than half an ounce.

north- to northwest-trending faults; one strikes more westerly, the Hope fault. In most cases mineral deposits are in or related to major fault structures. Although only a small part of the County has been mapped in sufficient detail to permit the accurate delineation of the large faults, mineralization of note was found associated with many of the major breaks in the Libby and Trout Creek quadrangles. When detailed mapping is done over the entire County it will most likely be found that other ore deposits are also related to the major fault systems. Mineralization is, in general, not associated with the major faults because of heavy fault clay, but the smaller associated fractures are sometimes found to contain important ore bodies.

Most of the larger faults are believed to be post-folding because several major folds are truncated by the faults. The more northwesterly-trending faults are cut by the great Hope fault along the Clark Fork River.

Apparent displacements along some of these major breaks are enormous. A stratigraphic displacement of about 18,000 to 20,000 feet along the Hope fault is reported by Anderson (1930, p. 45). The Rock Lake fault is 12 miles long and has a vertical displacement of 2,500 feet, and the Lenia fault, traced down the Bull Lake trench and into Sanders County a short distance, is believed to have a displacement of 26,000 feet (Gibson, 1948, p. 41 and 46).

The structural history of parts of western Montana and adjoining areas is more fully described by Clapp, 1932; Gibson, 1948; Jenks, 1938; Campbell, 1960; Calkins and MacDonald, 1909; Walcott, 1906; Wallace and Hosterman, 1956; Ransome and Calkins, 1908; and Anderson, 1930.

HISTORY AND PRODUCTION

Sanders County was established February 7, 1905 from part of Missoula County. It was named after U. S. Senator Wilbur F. Sanders.

Prior to the coming of the white men, the area was the home of the Kalispell, Pend d'Orielle, and Flathead (Salish) Indians. In 1809 a Northwest Fur Co. trader, David Thompson, constructed the famous Salish House trading post and fort on the Clark Fork River about 8 miles upstream from present-day Thompson Falls. In 1827 the post was moved up river about 10 miles near the vicinity of the present town of Eddy. Thompson Falls and the Thompson River bear the trader's name.

The discovery of gold in the Coeur d'Alenes started a rush of people into and through western Montana. Real impetus was given to the migration when the Northern Pacific Railroad entered the region in 1883. During the Coeur d'Alene gold rush it is believed that many of the mines and prospects were found in Sanders County. Accounts in the early 1880's mention mines in operation on Thompson River. Unfortunately, no production records have been preserved for the period prior to 1906, but records from 1906 to 1961 are presented in tables 1 and 2.

TABLE 2.—Production of gold and silver at placer mines, Sanders County, Mont., 1906-61. (County created February 7, 1905.)

Year	Material Treated Yds.	Gold Oz.	Silver Oz.	Total Value
1906-12	No production	—	—	—
1913	—	28	3	$ 572
1914	—	38	4	796
1915	—	31	5	634
1916	—	10	—	212
1917	—	3	—	53
1918-19	No production	—	—	—
1920	—	1	—	24
1921-22	No production	—	—	—
1923	—	2	—	39
1924-28	No production	—	—	—
1929	—	2	—	50
1930-31	No production	—	—	—
1932	700	22	—	463
1933	2,559	61	17	1,263
1934	—	108	17	3,779
1935	6,650	73	14	2,573
1936	3,756	36	5	1,250
1937	2,891	24	9	847
1938	4,462	22	—	770
1939	2,825	15	—	525
1940	4,200	27	—	945
1941	1,592	31	7	1,090
1942	150	5	—	175
1943-45	No production	—	—	—
1946	5,000	32	5	1,124
1947-58	—	—	—	—
1959-61	No production	—	—	—
Total	34,785	571	86	$17,184

MINES, PROSPECTS, AND MINING COMPANIES

BLUE CREEK DISTRICT

This small mining district is perched at the far western end of Sanders County and could be considered an extension of the Clark Fork district in Idaho, which borders it on the west. However, as far as Sanders County is concerned, the district embraces the drainage of the East Fork of Blue Creek. Blue Creek proper is a southward-flowing tributary of the Clark Fork River and enters the river about one mile east of the Idaho line. (See Fig. 3.)

The dominant geologic feature is the Hope fault, a large northwest-trending transverse fault that has been traced from Hope, Idaho, to Heron, Montana, although it most likely extends farther both east and west. The apparent displacement of the fault is enough to stagger the imagination. Anderson (1930, p. 45) points out that as a result of the Hope fault, the Burke and Striped Peak

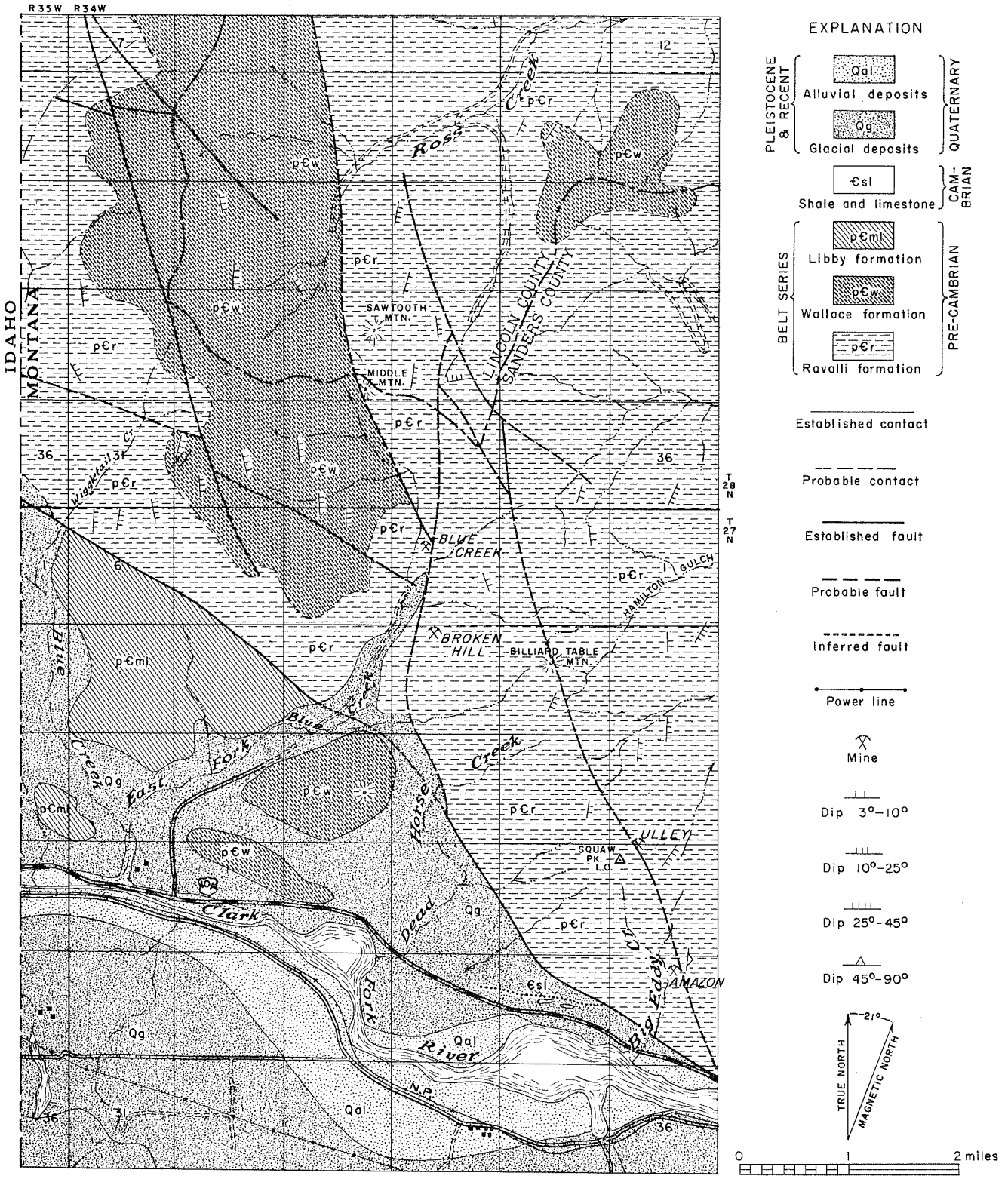

FIGURE 3.—Photogeologic interpretation map of the Blue Creek mining district. (From Northern Pacific Railway Co. photogeologic map folio sheet 3, 1959.)

Formations are side by side near the Montana-Idaho line and that near Scotchman Peak in Idaho, the Striped Peak Formation abuts against Prichard. The latter would involve a stratigraphic displacement of 18,000 feet. Farther west in Idaho, the Wallace Formation lies in juxtaposition with the middle Prichard, an apparent displacement of more than 20,000 feet. Immediately north of Fatman Mountain the Wallace Formation is in contact with the Burke Formation. Offsets in faults and folding and displacement of mean topographic levels on either side of the fault has led Anderson (1930, p. 45, 46) to suggest that the Hope fault, like the famous Osburn fault in the Coeur d'Alenes, has had a large horizontal movement as well as some vertical movement.

In the Clark Fork mining district of Idaho, Anderson (1930, p. 57) has distinguished between two types of ore deposits on the basis of geography and genesis of the ores. Mesothermal ore deposits, those containing principally galena, silver-bearing tetrahedrite, sphalerite, pyrite, arsenopyrite, and chalcopyrite, occur south of the Hope fault. The hypothermal ore deposits north of the Hope fault contain essentially the same minerals with the exceptions of less tetrahedrite and the addition of pyrrhotite. Siderite, a common vein mineral in the medium-temperature deposits, is apparently lacking in the high-temperature deposits. The most valuable deposits of the two are the silver-bearing ores south of the fault where argentian tetrahedrite is abundant. North of the Hope fault, the silver-bearing tetrahedrite is not common.

Veins in the Clark Fork district and in the Blue Creek district are replacement deposits along or near faults. The Hope fault which is the largest fault is not mineralized. Its heavy clay gouge is probably an effective dam, which prevents the passage of mineralizing solutions. Fractured zones, near the smaller faults or the fault planes themselves where clay formation has been slight, offer the best locii for mineralization. Consequently, future prospecting in this area should be confined to the wall rocks on either side of the Hope fault near the smaller subsidiary faults.

Quartizitic rocks in the Belt Series are noteworthy ore-carriers because of their brittleness. The Coeur d'Alene mining district is a well-known example. At the Blue Creek mine mineralization is in the Burke Formation (Anderson 1930, p. 106) which is predominantly quartizitic; this however, is no guarantee that all ore deposits in the district will be found in the same formation. In the Clark Fork district of Idaho, a few miles west of the Blue Creek district important lead-silver ore deposits have been discovered near major faults in the Wallace Formation (Anderson, 1930, p. 18). Other veins, though less important, have been observed in the Prichard and St. Regis Formations.

AMAZON

This prospect is near the head of Big Eddy Creek in the NE¼ sec. 25, T. 27 N., R. 34 W. The property is held by the Amazon Mining Co. Development is by shallow surface pits.

Serpentized Ravalli Formation rocks have been cut by scattered minute veinlets which contain tetrahedrite and chalcopyrite. Rarely are the veinlets over one-half inch in width and the included tetrahedrite and chalcopyrite grains are usually not greater than 2 mm. (millimeters) wide.

Mineralization and serpentinization are probably related to the large northwest-trending fault which passes through Billiard Table Mountain and just to the east of Squaw Peak. (See Fig. 3.)

BLUE CREEK (SCOTCHMAN, STACKHOUSE)

The Blue Creek mine is 4 miles north of U. S. Highway 10-A on the east fork of Blue Creek in sec. 3, T. 27 N., R. 34 W., at an elevation of about 3,150 feet above sea level. Six patented claims make up the property—Scotchman Nos. 6, 6½, and 7, Blue Creek Nos. 1 and 2, and Hillside.

Present owner is the Blue Creek Mining Co., which was incorporated in 1923. (See also Montana Gold Mining and Milling Co. on page 15.) The mine was intermittently developed until the late 1930's and it is reported that 20 men were employed during that time. In 1937, 108 tons of ore were shipped with a recoverable metal content of 6 ounces gold, 521 ounces silver, 306 pounds copper, 32,593 pounds lead, and 20,000 pounds zinc.

Development consists of two adits. (See Pl. 2A, in pocket.) The northernmost adit is accessible for 530 feet and the southern adit has about 920 feet of accessible workings. Cave-ins were encountered at the ends of both adits.

In the southern adit the vein has been stoped along the strike about 30 feet and upward about 35 feet. The face of this stope shows about 5 feet of banded ore. A winze and stope below the sill are water-filled.

Two veins are exposed underground; both are replacement veins near major faults in sheared and broken quartzite and argillite. The two vein exposures may be faulted segments of the same vein.

In the northernmost adit the vein strikes N. 55° W. and dips 53° SW., and is composed of fragments of the quartzite wall rock cemented by sulfide-bearing vein quartz. Vein contacts are indistinct because of numerous fragments of wall rock in the vein and because of braided fault clay.

Eighty feet from the portal the drift makes a small double bend, but the vein appears to continue along its strike. The drift follows a zone of fault gouge, fragments of drag ore, and brecciated

wall rock. Numerous small veinlets from 1 inch to 6 inches wide containing quartz, galena, and pyrite also occupy this zone.

The large fault encountered in the north adit is not exactly one massive fault but is, perhaps, more correctly termed a shear zone composed of numerous closely-spaced fault planes with intercalated fragments and lenses of brecciated wall rock. Faults and small shear zones parallel to the major fault do not appear to continue far along their strike. This may be a significant feature when considering the nature of ore bodies, which occupy shear zones near the major faults, rather than the clay-filled major faults. For the most part the major fault is iron stained, but locally minor copper stain was observed along with scattered lenses and fragments of sulfide-bearing vein quartz.

The vein in the southern adit was intersected 380 feet from the portal. At this point the underground workings are about 200 feet beneath the surface. The mineralized zone is 14 feet wide and is composed of numerous irregularly-shaped parallel veinlets and lenses, from 1 inch to 2 feet wide in altered and sheared argillite and quartzite.

The southeast drift follows the vein which strikes N. 30° W. and dips from 41° to 64° SW. until the vein pinches out near the intense northwest-trending fault. This shear zone is of the same type as that observed in the north adit and is probably the underground equivalent of the north-south fault in figure 3. Fragments of vein quartz and iron staining are common throughout the fault clay and between pieces of brecciated wall rock.

Mineralization is more concentrated in the southern adit, and the vein is prominently banded. Contorted bands rich in one sulfide, but which cannot be traced far in any direction, are interlayered with bands rich in another sulfide mineral. Pyrrhotite, arsenopyrite, galena, or sphalerite may predominate in any of the bands but are always accompanied by lesser amounts of other sulfides.

Wall rock near the vein is fractured and altered to sericite and chlorite. Fresh wall rocks are dark-grey to black fine-grained slightly calcareous argillites, argillaceous quartzites, and quartzites which strike N. 26° E. and dip 18° to 23° SE. A few feet east of the vein in the southern adit wall rock strikes N. 14° W. and dips 71° NE. Near the portal of the upper adit bedding strikes southeast and dips 63° NE.

Sample locations are shown on plate 2A, and their respective analyses are found in table 3.

Sulfide minerals in the Blue Creek veins are pyrite, arsenopyrite, pyrrhotite, sphalerite, chalcopyrite, galena, and marcasite in a gangue of vein quartz and fragments of quartzite and argillite. Minor amounts of tourmaline were noticed in a few specimens.

As mentioned before the most noticeable feature of the veins is banding. These mineralogically rich bands seems to swirl and flow through the veins like stream currents, parting in front of an island of quartz and joining and eddying on the opposite side. This texture appears to be a product of movement within the structure during or after mineralization. Either pyrrhotite, galena, or sphalerite comprise the bulk of any one band, which also contains minor quantities of the other two. Pyrite and arsenopyrite are generally scattered indiscriminately through the bands. However, arsenopyrite is locally abundant and may be the principal mineral in one of the bands. Marcasite, which replaces pyrite and pyrrhotite, is a very minor constituent.

The sequence of deposition is approximately that of the order above with pyrite and arsenopyrite being the first sulfides and galena the last. It is most likely that overlapping deposition is a more correct term to use here than is successive deposition. For example, sphalerite appears to have been deposited simultaneously with galena in some specimens. In others, galena is later. Both started deposition about the same time, but the deposition of galena continued beyond that of sphalerite. Most chalcopyrite occurs as exsolution blebs in sphalerite, but occasionally forms a megascopically visible mass. Although a minor quantity of pyrrhotite is found as tiny blebs in sphalerite, it occurs most abundantly as masses and individual grains.

The most striking feature of the ore minerals as seen through the microscope is the extremely fine grain size. Figure 4 shows the interrelation-

TABLE 3.—Ore analyses, Blue Creek mine. (Au, gold; Ag, silver; Cu, copper; Pb, lead; Zn, zinc; As, arsenic; Sb, antimony; Bi, bismuth; SiO_2, silica; CaO, calcium oxide; Fe, iron.)

Sample No.[1]	Au (oz.)	Ag (oz.)	Cu (%)	Pb (%)	Zn (%)	As (%)	Sb (%)	Bi (%)	SiO_2 (%)	CaO (%)	Total Fe (%)
SNC-1	0.040	1.1	0.22	4.8	3.1	1.6	Nil	0.50	61.0	0.5	10.3
SNC-2	0.040	0.6	0.08	0.6	2.0	0.7	Nil	0.92	68.6	2.7	4.3
SNC-3	0.030	1.7	0.06	6.1	6.6	0.7	Nil	0.28	56.0	1.2	9.0
SNC-4	0.020	0.9	0.08	3.3	4.1	0.8	Nil	0.52	58.8	1.6	9.3
SNC-5	0.005	0.2	Nil	Tr	2.3	0.9	Nil	0.40	67.6	0.7	10.1

1—SNC-1, 6-foot channel sample, southern adit; SNC-2, 3½-foot channel sample, hanging wall of vein, southern adit; SNC-3, 2-foot channel sample foot wall of vein, immediately below SNC-2; SNC-4, grab sample from chute mouth, southern adit; SNC-5, 4-foot channel sample 20 feet from portal, northern adit.

ship between some of the sulfides and by comparing the average grain size with the superimposed 100 mesh screen the difficulties that will be encountered in grinding and beneficiation can be seen.

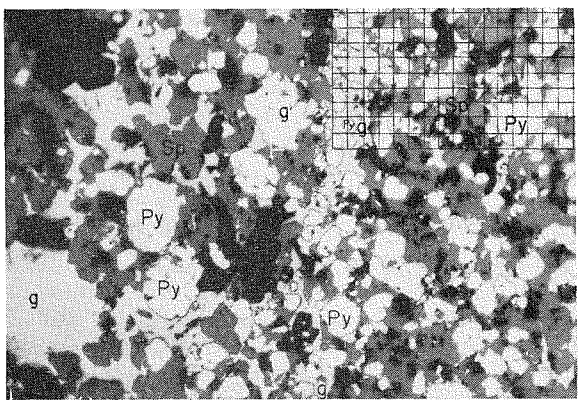

FIGURE 4.—Photomicrograph of ore from the Blue Creek (Scotchman, Stackhouse) mine, Blue Creek mining district (Py—pyrite; g—galena; Sp—sphalerite) (135x).

BROKEN HILL

The Broken Hill mine is in sec. 10, T. 27 N., R. 34 W., about 3½ miles north of U. S. Highway 10-A. Two patented claims, the Bobby and Broken Hill, are about three-fourths of a mile southeast of the Scotchman mine. The main workings, which are high on the slope east of the East Fork of Blue Creek, can be seen from the Blue Creek road, but are accessible only by a rather indistinct brush-covered trail.

In the early 1920's the property was owned by the Broken Hill Silver-Lead Mining Co., which was incorporated in 1922 in the State of Washington. In 1923 the mine was leased to the Federal Mining and Smelting Co., but the company relinquished its option in 1924. Between 1925 and 1926 the mine was leased on a royalty basis to H. C. Conn who reportedly was shipping one car of ore a month. Records in the County Clerk and Recorder's office in Thompson Falls list as present owners: William H. Swann, Ruth Goddard, and Preston Swann. Former owners were Walter J. Nicholls and the Continental Mining Co.

Records compiled by the Federal Bureau of Mines show production in 1925, 1926, and 1927. (See table 4.) Some of the lead-zinc ores from the Broken Hill were shipped to Portland, Oregon, for export in 1925. In 1926 four cars of ore were exported to Belgium and in 1927 a test lot of ore was shipped to the Sweeny custom plant near Kellogg, Idaho, where lead and zinc concentrates were made.

The property was developed by two adits, but both were caved at the portal in 1960. The Mines Handbook (1925, p. 1280; and 1926, p. 1046) reported that two adits were 108 feet and 350 feet long; the uppermost adit intersected the vein 100 feet below the outcrop and was connected to the lower adit, 110 feet below by a raise. At a distance of 280 feet from the portal of the lower adit a 23-foot (?) vein was intersected. It is reported that the vein contained 8 feet of low-grade ore and 15 feet of high-grade which assayed 12.5 ounces of silver, 24.4 percent lead, and 22.2 percent zinc. However, Gibson (1948, p. 120, 121) reports that the "ore is said to have pinched out at or above the level of the lower adit, though the shear zone is well marked at that depth." According to Gibson (1948, p. 120) a portion of the vein 80 feet from the portal of the upper level had been stoped upward for about 60 feet. The form of the stope indicated a northwest raking oreshoot along the Blue Creek fault, which strikes northwest and dips steeply northeast. The ore body is described as being exceedingly irregular and pinches within a short distance from 30 inches to 9 inches or less.

A grab sample of heavy sulfide-bearing ore from the dump assayed 0.01 ounce gold, 2.2 ounces silver, 0.08 percent copper, 7.6 percent lead, 21.5 percent zinc, 23.2 percent silica, and 15.0 percent total iron. Arsenic, antimony, and calcium oxide were not detected, and bismuth was present only in trace amounts.

The mineralogy of selected dump samples from the Broken Hill is much the same as for the Blue Creek mine. Pyrite, pyrrhotite, sphalerite, galena, chalcopyrite, and arsenopyrite are present in a gangue of quartz, tourmaline, and tremolite. Tourmaline is a much more abundant constituent in this ore than in the Blue Creek veins. Tourmaline and tremolite occur as a network of fine needles throughout sphalerite and galena. Some of the needles are less than 0.008 mm. wide.

Mineralogically rich bands occur in hand specimens and the very fine-grained texture is evident microscopically. Pyrrhotite and arsenopyrite, especially the latter, are not as abundant

TABLE 4.—Production of gold, silver, lead and zinc, Broken Hill mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
1925	88	—	228	—	16,896	62,832
1926	140	—	526	—	25,200	105,196
1927	45	—	188	—	10,961	8,604
Total	273	—	942	—	53,057	176,632

as in the Blue Creek ore. However, too much credence cannot be placed on hand samples from the dump, for they may represent only one portion of the vein.

MONTANA GOLD MINING AND MILLING COMPANY

The following information has been taken from mining magazines concerning the operations of the Montana Gold Mining and Milling Co. on Blue Creek. Although the whereabouts of this company's property were never given in sufficient detail to eliminate doubt, it is the writer's belief that the mine developed by this company in the early 1910's and the Blue Creek mine are one and the same.

This company was incorporated late in 1908 in Spokane, Washington, with a capitalization of $1,000,000. In the same year a contract for tunnel and drift work was let to develop free milling gold ore on 3 claims, 3 miles north of Heron. It was reported that during development work on one of three ledges, gold assays were obtained ranging in value from $40 to $125 (The Mining World, Nov. 28, 1908, p. 824).

During the summer of 1909 it was reported that an ore body in the shaft contained ore which assayed $120 per ton in free gold, and a contract was let for 1,000 feet of adit (Mining and Science Press, May 1, 1909, p. 605). Late in the summer of 1909 the drift had been driven 75 feet. "At 45 feet a stringer of ore was cut, but the miners will drift 20 feet farther to strike the ledge found on the surface." (The Mining World, Aug. 14, 1909, p. 388).

The September 2, 1911 issue of Mining and Engineering World (p. 447) reported "considerable development work has been done and 23 feet of tunnel has been driven in one of the claims, drifting along a lead which runs from 8 to 18 inches wide and averages $10 in free milling gold. * * * There is about 3 feet of talc along the hanging wall and the vein is increasing in size and richness as the work progresses. * * * Twelve men are now at work on the property and a blacksmith shop and bunkhouse have been built. * * * The company has a millsite and plenty of water close to the portal of the tunnel and a wagon road extends all the way from the mine to the railroad station."

Mining and Engineering World (Jan. 13, 1912, p. 90) reports the property as being 4 miles west of Heron and that development work was being done on a 4-foot ledge of free milling gold ore. The same magazine for August 30, 1913, (p. 390) reported an assay of $217 per ton mainly in gold.

No further mention can be found concerning this company.

ULLEY (SQUAW PEAK)

The Ulley prospect is in S½ sec. 13, T. 27 N., R. 34 W. at an elevation of about 5,200 feet above sea level. It is reached by a Forest Service trail up Star Gulch to the Squaw Peak lookout station. The prospect is about half a mile northeast of the station.

In the early 1930's the prospect, consisting of four unpatented claims, was being developed by the Dixie Queen Mining Co. (The Mines Handbook, 1931, p. 1304). A small inclined shaft 50 feet deep was said to contain 30 inches of "grey copper" (Mining Truth, 1928, v. 13, no. 11, p. 10). Gibson (1948, p. 124) reported that "A short crosscutting adit has been driven to explore a quartz vein that has a maximum thickness of 12 inches. * * * A second crosscut adit 100 feet below the first had not penetrated the vein when the property was visited in 1934." There is no record of production for the Ulley prospect. During the summer of 1960 only a few feet of the inclined shaft was accessible; the bottom was water filled.

The vein, which cuts across bedded white quartzite, is about 15 inches wide. It strikes N. 40° W. and dips 64° SW. The massive Ravalli Formation quartzites (Revett ?) strike N. 5° E. and dip 45° SE.

Vein minerals are quartz, magnetite, chalcopyrite, hematite, limonite, and minor malachite. Magnetite, hematite, and chalcopyrite are the most abundant and occur with vein quartz cementing rounded fragments of wall rock. Magnetite encloses numerous small blebs of chalcopyrite which seldom exceed 0.02 mm. in diameter, but chalcopyrite and magnetite occur predominantly as large grains and masses up to 2 inches wide.

CAMAS PRAIRIE DISTRICT

The Camas Prairie district, for the purpose of this report, embraces a large area north of Perma to the Lincoln County line.

Since 1912 the district has produced a relatively large amount of copper ore. Tables 5, 6, and 7 show production of individual mines. The total production of the district from 1912 to 1947 (no production 1948 to 1958) is 1,506 tons of ore from which 23 ounces of gold, 2,401 ounces of silver, 123,880 pounds of copper, and 4,632 pounds of lead were recovered. Total value of all ores is $24,204 or an average value of $16.07 per ton.

The district is underlain by the Prichard Formation—a thick series of light- to dark-grey banded and thin-bedded argillites and sandy argillites. Vividly shown on the geologic map and conspicuous in the field are the massive sills which are dioritic to gabbroic in composition. The

TABLE 5.—Production of gold, silver, copper and lead, Glaucus mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)
1912	3	—	88	162	2,532
1917	3	—	71	204	1,159
1926	1	—	34	22	941
1942	10	—	14	1,700	—
1943	77	1	135	5,300	—
1944	233	4	405	19,400	—
1945	345	5	585	25,800	—
1946	430	8	578	31,200	—
1947	302	3	379	21,500	—
Total[1]	1,404	21	2,289	105,288	4,632

1—Average grade calculated from totals: gold (average for last 5 years), 0.015 ounce per ton; silver, 1.63 ounces per ton; copper, 3.75 percent; lead (average for first 3 years), 33.08 percent.

Glaucus mine is in a zone of bleached argillite, but the Camas Copper Mining Co. and the Duston Group were apparently near the sills, some of which are porphyritic.

The Ravalli Formation underlies a narrow strip along the western edge of the district and in the far north corner near Niarada there are a few small areas covered by Tertiary volcanic rock and Tertiary sediments. The basin of Camas Prairie along the Little Bitterroot River is covered with glacial lake deposits.

As far as is known, the only economically significant mineral commodity other than metal veins in the Prichard is the Tertiary volcanic tuffs. The tuffs in Sanders County are composed predominantly of sanidine, kaolin, partially devitrified volcanic glass, and minor quartz along with pebbles of a fine-grained diorite (?). It is planned to use some of this material as pozzolan, but its composition seems to be too low in silica for this use. However, it has been reported that volcanic tuffs north of Sanders County do contain a high enough silica content for use as a pozzolanic cement additive.

GLAUCUS (HERMAN)

The Glaucus mine is in sec. 20, T. 19 N., R. 22 W., 10.8 miles northeast of Perma. There are four patented claims, adjoining on their end lines that form an east-west line through the W½ sec. 20 and into the E½ sec. 19, T. 19 N., R. 22 W. Evidence of the most work is on the Glaucus claim at the eastern end of the line of claims. The Glaucus and the next two claims west, Cardiff No. 2 and Cardiff No. 1, are owned by Rodney and Marion R. Kruger. The Cardiff on the far western end is owned by Charles G. Love.

During the summer of 1961 all openings to the mine, a shaft and several adits, were caved. One of the adits was driven into the hillside in a N. 65° W. direction and from the size of the dump, it was estimated to be about 500 feet in length. The area of the claims is underlain, in most part, by the typically banded thin-bedded argillite of the Prichard Formation, but near the shaft and adits the rock is a white sandy argillite that appears to have been bleached by hydrothermal solutions.

A few scattered ore samples on the dump were composed of limonite-stained quartz, malachite, azurite, and copper pitch, but no sulfide minerals were seen.

Little of the mine's early history is known except that in the 1940's the mine was owned by a Mr. Cris Herman.

Total production for the Glaucus mine is shown in Table 5.

OTHER PROPERTIES

The *Exchange* and *June Bug* mines were not visited. Their production, however, as listed in the Camas Prairie district, is shown in Tables 6 and 7 respectively.

TABLE 6.—Production of gold, silver, and copper, Exchange mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)
1915	13	—	14	1,931
1916	32	1	48	8,024
1917	33	1	40	7,174
Total[1]	78	2	102	17,129

1—Average grade calculated from totals is: gold, 0.025 ounce per ton; silver, 1.31 ounces per ton; copper, 10.9 percent.

TABLE 7.—Production of silver and copper, June Bug mine.

Year	Ore (tons)	Silver (oz.)	Copper (lb.)
1916[1]	24	10	1,463

1—Average grade calculated from total: silver, 0.417 ounce per ton; copper, 3.2 percent.

An early issue of the Copper Handbook (1912-13, p. 330) lists the *Duston Copper Group* as follows:

"*Duston Copper Group*: Located in Sanders County, 6 miles north of Perma, on the N.P.R.R. on the Flathead reservation. Property: 5 claims

unpatented; only 1, the Duston being developed. Vein occurs along contact between granite and porphyry (?) is developed by a 100-foot tunnel showing an ore body 50 feet long, 4½ feet wide, carrying 16 percent copper, 2 ounces of silver and good gold values. Only assessment work being done on property. Adjoins the Camas Copper Mining and Milling Company."

The Copper Handbook (1910-11, p. 542) contained the following description on the *Camas Copper Mining and Milling Co.*: " * * * Lands; 2 claims unpatented area 40 acres with a 5-acre millsite adjoining on the Flathead Indian reservation showing a vein of 3 feet to 4 feet width, said to lie between porphyry and granite, carrying ore giving assays of 18.1 percent copper, 1 ounce silver, and 60 cents gold per ton. Company plans sinking a shaft and driving a tunnel."

EDDY CREEK-SWAMP CREEK DISTRICTS

The area enclosed by the heretofore unnamed Eddy-Swamp Creek districts coincides with the drainage of these two north- to northeast-flowing tributaries of the Clark Fork River. For the most part the creeks drain T. 20 N., R. 27 and 28 W. and northern parts of T. 19 N., R. 27 and 28 W.

The youthful swift-flowing streams have cut steep-walled canyons across a northwest-striking anticline, exposing at its center the Prichard Formation and on its limbs the overlying Ravalli Formation.

Prospected since the early 1900's, many quartz veins containing galena and arsenopyrite have been uncovered on both creeks, but there is no record of production—at least there is no record as to names known today.

In 1906 the Eddy "mine" was being developed by a crosscut adit, and the ore was said to run $8 to $36 per ton in gold, silver, and lead (The Mining World, June 30, 1906, v. 24, no. 26, p. 788).

Also in 1906, a short paragraph in the Mining World (Aug. 4, 1906, v. 25, no. 5, p. 137) noted that rich tellurium float had been found on Prospect and Eddy Creeks. The find started a stampede of prospectors into the area. However, nothing further was published concerning additional telluride finds. By August 11, 1906 (no. 6, p. 166) the same magazine reported that the crosscut adit 375 feet long at the Eddy mine had intercepted a 5-foot vein of high-grade lead-silver ore said to average more than 40 percent lead and 5 ounces silver per ton.

The Coeur d'Alene Star, Kokomo, and Mineral King were reported to be promising lead-silver prospects in 1907 (The Mining World, v. 27, no. 3, p. 121). Between 1906 and 1919 many companies tried their hand in the Eddy Creek district, but apparently none succeeded. The companies mentioned as doing development work in or near Eddy Creek were the Jewel Mining and Milling Co., the Mexico-Coeur d'Alene Mines Co., and the Missouri Mining and Milling Co.

During later years the State Mining Co. did considerable development work on both Eddy and Swamp Creeks. Eleven patented claims on Eddy Creek are known as the Russell Group after W. B. Russell, who patented the claims. Prior to the ownership of the State Mining Co., the group was owned by John W. Miller, who also developed several galena-bearing quartz veins on Swamp Creek. The Swamp Creek workings are still known as the Johnny Miller.

In 1960-61 the Montana Coeur d'Alene Mining Co. optioned both the Russell and Johnny Miller prospects, and during 1961 the company was opening several caved adits and had contracted a number of diamond-drill holes to test the downward extension of several veins that outcrop at surface.

RUSSELL GROUP

Near the head of Eddy Creek in sec. 16 and 21, T. 20 N., R. 28 W., is a group of claims known as the Russell Group. Eleven of the claims owned by the State Mining Co. shown on plate 2B are patented: the Bluebird, Pansy, Mary, Homestake, Hummingbird, Bay Chief, Bay Chief Extension, Ravalli, Green Mountain, Independence, and Champion. Unpatented claims held by Wesley Stearns and Wendell Stephens are the Morning Star, Morning Star Extension, Morning Star No. 2, Bay Chief No. 3, and Bay Chief No. 2; Bay Chief No. 2 is contiguous to Bay Chief No. 3 and is not shown on map.

Heavy overburden blankets most of the area, but from scattered outcrops it appears that the area is underlain by one or more sill-like bodies whose mineral composition ranges from that of diorite to gabbro. The outline of the bodies parallels closely the prevailing strike of the bedded argillites, believed to be part of the upper Prichard Formation.

The diorite and gabbro are, most likely, slightly different mineral phases of the same intrusive. The diorite phase is the more predominant, but both can be seen in a single outcrop.

The argillite is principally thin bedded and ranges in color from light grey to black, but weathers a deep brown. Light and dark beds usually alternate giving the rock a striped or banded appearance. For the most part, the argillite strikes N. 30° to 40° W. and dips 29° to 85° SW. Owing to minor folding or faulting, some beds dip northeast.

Mineralization occurs in northwest-striking quartz veins that range in width from a few inches to 8 feet. Many of the veins dip to the northeast, but a few appear to be vertical. The veins occur in both the diorite and in the argillite. On the Bay Chief claim the vein is about 8 feet wide, dips at one place 75° SW., and contains

TABLE 8.—Chemical analyses of diorite from the Pansy claim, Eddy Creek.

Sample No.	Gold (oz.)	Silver (oz.)	Copper (%)	Lead (%)	Zinc (%)	Platinum (%)	Cobalt (%)	Nickel (%)	Arsenic (%)
SNC-36	none	none	0.09	none	0.30	none	0.005	none	0.30
SNC-37	none	none	0.05	—	—	none	0.015	none	0.20
SNC-38	none	none	0.05	none	0.20	none	0.010	none	0.25

erratically distributed pods of very shiny and fresh looking galena, with some pyrite. Chalcopyrite is a minor constituent in some galena masses and is usually accompanied by minute rounded blebs of tetrahedrite. Other veins in both sedimentary and igneous rock are very similar in their mineralogical make up, but the veins in diorite are pod-like. In a short adit on the Bay Chief, quartz pods 3 to 4 feet long and up to 1 foot wide occur along a small northwest fault. In addition to the larger pods, there are many quartz veinlets 1 to 2 inches wide through the fine-grained blackish-green diorite. Mineralization is very minor in the quartz masses, consisting mostly of iron oxide and a few small grains of galena.

Near the large northwest fault and north-trending quartz veins on the Pansy claim the diorite is highly altered. It has a reddish-brown color, is very friable, and contains scattered flecks of sulfide, which were too altered to identify with certainty, but are believed to be arsenopyrite.

Three selected samples of the diorite were taken near the veins. SNC-36 is a brownish altered diorite near the western vein. A sample of unaltered black, fine-grained diorite is SNC-37, while SNC-38 is a reddish-brown altered diorite. The chemical analyses for SNC-36-38 are shown in table 8.

The analyses of channel samples (SNC-32-34) across several veins are shown in table 9. However, it should be rementioned that mineralization is very erratic on surface and the results of sampling cannot be considered as being representative of the entire vein.

Sample SNC-32 is a composite channel of three separate cuts across a 1-foot quartz vein on the Morning Star claim. Sample SNC-33 is a 3-foot channel across the western vein at the Pansy claim taken about 30 feet above the road at the portal of caved adit. On the Bay Chief claim, sample SNC-34 was channeled across 8 feet of vein.

Three geochemical soil-sampling traverses were made. (See pl. 2C.) Traverse EC-1 was taken along the first switchback on the Bay Chief claim. Sample spacing was 20 feet. One relatively strong and several weaker anomalies were revealed along the projection of the massive quartz vein. The major anomaly is slightly downhill from the vein's projection as would be expected. The minor anomalies may indicate minor mineralized areas or erratic samples.

Soil traverse EC-2 taken 100 feet above the road cut on the Pansy claim revealed a high on the western end where the projection of the westernmost vein would be expected to cross and several other highs, one of which coincides with the projected fault. The double-peaked high between samples 6 and 10 may be due to an unknown vein.

Traverse EC-3 was taken parallel to the road above the long vein that crosses the east end of the Hummingbird claim. An east-west line of samples was taken because it was believed that the veins strike northwest. However, the low and inconclusive results strengthen the interpretation of the strike on the vein as shown on plate 2B.

JOHNNY MILLER

The Johnny Miller prospect is in the SW¼ sec. 31, T. 20 N., R. 27 W., on the West Fork of Swamp Creek about 14 miles southwest of Plains. The road to the property is accessible to trucks or 4-wheel drive vehicles.

Development consists of several caved adits and a few shallow shafts, all of which are inaccessible. One caved adit near the creek appears to have been driven about N. 30° W. in fine-grained black to dark-grey sericitic argillite of the Prichard Formation. From the size of the dump it is estimated that there are about 800 to 1,000 feet of underground workings.

TABLE 9.—Analyses of samples from Eddy Creek.

Sample No.	Gold (oz.)	Silver (oz.)	Copper (%)	Lead (%)	Zinc (%)	Antimony (%)	Arsenic (%)	Silica (%)
SNC-32	Tr.	0.6	0.12	Tr.	nil	nil	0.50	88.2
SNC-33	Tr.	1.4	0.10	0.5	nil	nil	0.40	76.1
SNC-34	Tr.	0.7	0.08	1.2	nil	nil	1.60	70.3

Two veins are exposed at surface; one at the mouth of a shallow shaft about 150 feet above the creek-level adit and the other in a road cut several hundred feet west of the adit.

Both veins are narrow. In the shallow shaft the vein is from 2 to 4 inches wide and strikes N. 40° W. and dips 68° SW. parallel to the bedding. The road-cut vein is 8 to 12 inches wide, strikes N. 35° W., and dips 72° SW. parallel to the bedding. Both veins are chiefly iron-stained milky quartz containing minor amounts of siderite and a few scattered grains of galena. Specimens on the dump at creek level contain irregular blebs of siderite, pyrite, arsenopyrite, galena, and hematite. A selected sample of this material contained 0.001 ounce gold and 0.07 ounce silver per ton plus 1.10 percent lead, no zinc, and 0.825 percent arsenic.

R & M #1

The R & M #1 prospect is about 1½ miles by trail west of the Johnny Miller on Swamp Creek. A short adit has been driven along a 5-foot bedding-plane vein that strikes N. 47° W. and dips 37° SW. The vein, in thin-bedded speckled light and dark argillite, is mostly milky quartz with pods of fresh-looking galena and arsenopyrite up to 6 inches long. It was estimated that the sulfide-mineral content, which occurs principally along the hanging wall, is less than 1 percent of the vein matter. The vein in places splits forming several 1- to 2-foot veins separated by 6- to 12-inch lenses of wall rock.

It is reported that there are one or two other prospects between the West Fork of Swamp Creek and Dee Creek, an eastward-flowing tributary of Swamp Creek. Mineralization is reported to be similar to that at the R & M #1 and the Johnny Miller.

NOXON-CABINET DISTRICT

Covering an area indefinite in shape and size north of Noxon, the Noxon-Cabinet district is characterized by rugged topography and a predominance of Ravalli and Wallace Formation sedimentary rocks.

The jagged Cabinet Mountains were formed by upthrusting and folding of Belt Series sediments which were later sculptured by glacial action. Both the Wallace Formation, which outcrops along Bull River and north into the heart of the mountains, and the Ravalli Formation along Rock Creek form precipitous cliffs and serrate ridges.

The Ravalli Formation in this area is about 10,000 feet thick and is composed predominantly of light-grey to white quartzite (Gibson, 1948, p. 11 and 12). About 12,000 feet of Wallace Formation have been measured on Mt. Berray, slightly west of the northwest edge of figure 5 (Gibson, 1948, p. 13). Described as the most heterogeneous formation in the Libby quadrangle, the Wallace is predominantly shaly and argillaceous with colors in shades of grey and greenish grey. Most of the formation is calcareous or dolomitic and generally weathers tan to brown.

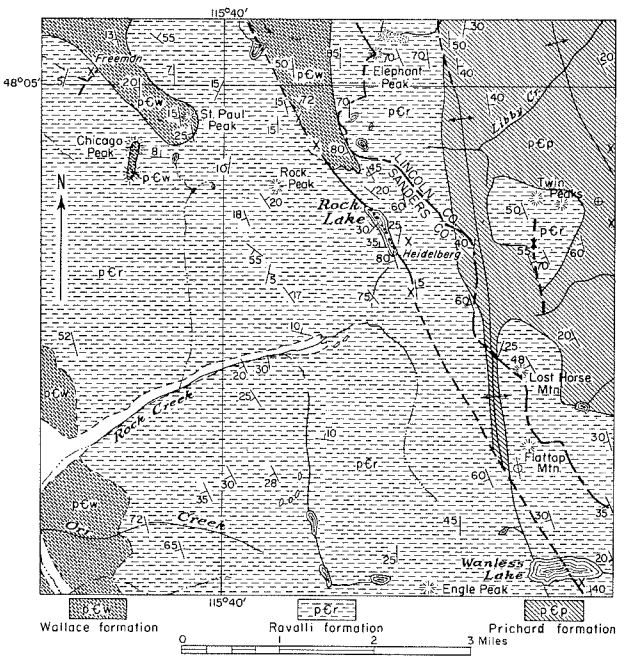

FIGURE 5.—Geologic map of part of Noxon-Cabinet mining district. (From Gibson, 1948.)

Igneous rocks are scarce in the area except for the small Hayes Ridge stock which is composed of a muscovite-bearing quartz monzonite. Basic sills are found in both Wallace and Ravalli Formations. The sills are crystalline medium-grained dark-green metadiorite.

Of primary interest, as far as mineralization is concerned, is the lengthy Rock Lake fault. Several prospects and one producing mine, the Heidelberg, have been developed on or adjacent to the fault whose vertical displacement is measured in thousands of feet. Production of gold has been recorded for the Heidelberg mine, but the other known prospect, a copper prospect known as the Freeman, has no recorded production.

CHILSON

There is a Chilson mine listed in production records of the Noxon district which produced copper ore in 1921 and 1922. Total production was 37 tons of ore which yielded 1 ounce gold, 50 ounces silver, and 7,051 pounds copper. Although listed in the Noxon district the 1922 Minerals Resources describes the mine as being near Perma. Such a mine could not be located in either the Noxon or Perma area.

FREEMAN

Gibson (1948, p. 123) described the Freeman prospect as follows: "The Freeman prospect is just above Copper Lake in Copper gulch at an altitude of 5,000 feet. (See fig. 5.) The country rock is the Ravalli Formation. Two short adits about 20 feet apart have opened a quartz vein 6 feet thick, which occupies a shear zone that strikes N. 48° E. and dips 46° NW. An inclined winze at least 80 feet deep was partly filled with water when the prospect was examined.

"The chief ore mineral is chalcopyrite, which is disseminated through the quartz. A little bornite is intergrown with the chalcopyrite, and both minerals are veined with chalcocite, malachite, and limonite. A selected sample of quartz high in chalcopyrite assayed 0.01 ounce gold and 0.06 ounce silver to the ton."

HEIDELBERG

The Heidelberg mine is in unsurveyed NW¼ sec. 32, T. 27 N., R. 31 W., near Rock Lake at an elevation of about 5,500 feet above sea level. (See fig. 5.) Although the Heidelberg Mining Co. holds 20 unpatented claims in the area, the main workings are in a relatively small area on the slope west of Rock Lake and adjacent to Rock Creek about a half a mile south of the lake. Both working areas are reached by a rough road that follows the creek to Rock Creek meadows and then by mine road up a steep slope southwest and west of the lake.

During the 1920's the R. J. Price Mining Co. was developing a group of seven unpatented claims along the Rock Lake fault between St. Paul Lake and Rock Lake. From the description of the company's operations it appears they were not developing the gold-quartz vein being explored by the Heidelberg Co. but were working on vein outcroppings in the Milwaukee Pass north of Rock Lake that contained copper and lead (Mining Truth, 1928, v. 13, no. 16, p. 6). By 1930 the Price Co. held 15 claims and had started a long crosscut adit to cut a silver-lead-gold vein at a depth of 450 feet (The Mining Journal, 1930, v. 14, no. 7, p. 46). This sounds like the start of the long adit whose portal is south of Rock Lake near the creek. Also at that time, Price was individually operating the Freeman property in Copper gulch.

In 1936 the operating company changed its name to the Heidelberg Mining Co. and work was continued on the crosscut adit (The Mining Journal, 1936, v. 20, no. 8, p. 20). This company has continued to do intermittent development work since 1936, and in 1960 the mine road was being built to connect the workings east and above Rock Lake with the main camp on the north side of the meadows.

The crosscut adit is about 780 feet long. It was driven in an attempt to intersect the east-dipping gold-quartz vein east of the lake. General trend of the adit is N. 65° E. It was stopped far short of its objective.

Above and east of Rock Lake several shallow inclined shafts have been started along a gold-bearing quartz vein. The deepest shaft is only about 25 feet deep. South of the lake on the creek are the remains of a small concentrating mill which includes a jaw crusher, ball mill, Wilfley table, and amalgamation drum.

Ravalli Formation sedimentary rocks underlie the area and comprise the high ridges east of Rock Lake. In the adit massive light-grey to dark-grey quartzites strike N. 30° to 35° W. and dip 60° to 70° SW. East of the lake the vein parallels bedding planes of light-grey to white quartzite that strikes north and dips 25° to 43° E. The Rock Lake fault which has been traced from Dad Peak northwest to about one mile south of Wanlens Lake, or a distance of at least 12 miles, has dropped the Wallace Formation against the Ravalli Formation near St. Paul Lake. According to Gibson (1948, p. 46) the fault, which strikes generally N. 33° W. and is vertical, has had a vertical displacement of about 2,500 feet.

The Price prospects in Milwaukee Pass are on the Rock Lake fault, but the Heidelberg's gold-quartz vein is slightly east of the fault. The gold-quartz vein, paralleling the quartzite bedding planes can be traced on surface for about 1,000 feet. Eighteen to thirty inches of massive white quartz is exposed in the shallow shafts, but along the vein to the north the vein widths range from 12 inches to 1-2 inches. Average width is about 5-6 inches. General strike is north and the dip ranges from 25° to 43° E.

Three channel samples were taken across the vein at the deepest inclined shaft. Table 10 lists results plus the results of other samples taken along the same vein.

The average value of samples SNC-20, 21, 106, 107, and 108 (using a weighted average of 20 plus 21 as 2.61 ounces) is 1.14 ounces of gold for approximately 150 feet along the strike of the vein. Silver to gold ratio is about 1:1.

Production from the Heidelberg mine is shown in table 11. The average gold content of the total 28 tons is 0.857 ounce per ton.

PILGRIM CREEK DISTRICT

Pilgrim Creek is a northeast-flowing tributary of the Clark Fork River. It joins the river near the town of Noxon, a station on the Northern Pacific Railway. The district, although unorganized, is here designated a district for the sake of conveniently cataloguing mines. The district is considered as embracing the drainage of Pilgrim Creek.

TABLE 10.—Analyses of samples from the Heidelberg mine.

No.	Gold (oz.)	Silver (oz.)	Lead (%)	Zinc (%)	Copper (%)	Silica (%)
SNC-20[1]	2.08	2.70	1.8	Tr	Tr	75.4
SNC-21[1]	3.06	3.00	1.3	Tr	Tr	91.0
SNC-22[1]	0.14	0.40	1.3	Tr	Tr	67.3
SNC-23[2]	0.36	0.60	1.1	Tr	Tr	76.2
SNC-106[3]	0.41	0.20	—	—	—	—
SNC-107[4]	1.46	1.95	—	—	—	—
SNC-108[5]	0.28	0.30	—	—	—	—

1—See figure 9.
2—Grab sample from ore bin near creek.
3—28-inch channel sample across vein in southernmost shaft east of Rock Lake.
4—30-inch channel sample across vein 50 feet north of SNC-106.
5—25-inch channel sample across vein 50 feet north of SNC-107.

TABLE 11.—Production of gold and silver, Heidelberg mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)
1937	3	1	1
1939	20	20	12
1940	5	3	—
Total	28	24	13

Geologically, the district is relatively simple. Two major formations are present: the Wallace and Striped Peak. (See fig. 6.) The Wallace Formation, as measured by Gibson and others (1941, p. 372), is 10,500 feet thick in the vicinity of Huckleberry Mountain and is composed predominantly of light-grey to greenish-grey argillites. The argillites which weather brown to light tan in color may be more or less quartzitic, but are usually calcareous or dolomitic. Near the top of the formation the Wallace contains some red beds simliar to the lower part of the Striped Peak Formation (Gibson and others, 1941, p. 373). Ripple marks and mud cracks are evident in many outcrops and molar-tooth structure is relatively common.

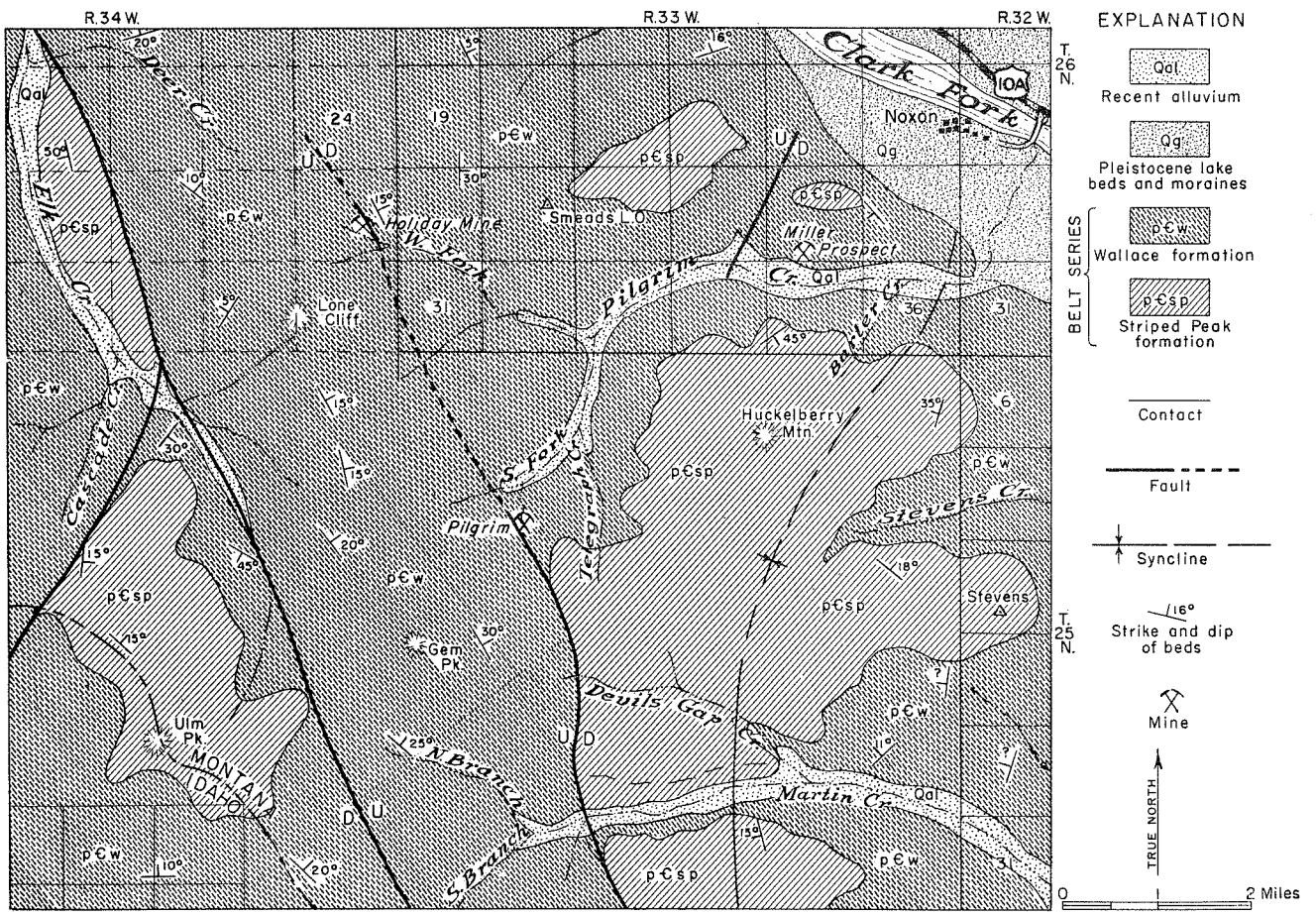

FIGURE 6.—Geologic map of Pilgrim Creek mining district and surrounding area.

Lying conformably on top of the Wallace Formation is the lower portion of the Striped Peak Formation. The top of the Striped Peak has been removed by erosion. Not only is the Striped Peak higher stratigraphically, but in the Trout Creek-Pilgrim area it is also topographically higher—occupying tops of ridges and mountain tops, except along certain portions of a synclinal axis on Martin Creek and near the mouth of Pilgrim Creek. "The Striped Peak is an accumulation of red and green argillites and quartzites with mud cracks and other signs of shallow-water deposition" (Calkins, 1909, p. 38 and 39). North of Pilgrim Creek the Striped Peak Formation is composed of dark-red to purplish sandstone and quartzite; the beds are more shaly and greenish colors become evident.

All evident mineralization in the Pilgrim Creek district is in the Wallace Formation. The Holliday and the Pilgrim mines are near the Holliday fault which is here named because of its exposure in the Holliday mine. Jenks (1938) mapped this fault as shown by the solid line in figure 6, but its extension matches so well with the fault in the Holliday mine that the author has extended it (dotted portion) to and slightly beyond the mine. Mineralization is most likely related to the fault, but as in most other cases in Belt rocks the mineralization has followed minor, relatively clay-free fractures to one side of the major faults.

HOLLIDAY (HOMESTEAD)

The Holliday mine is in S½ sec. 25 and N½ sec. 36, T. 26 N., R. 34 W., about 10½ miles southwest of Noxon near the headwaters of the West Fork of Pilgrim Creek. Holliday Mines, Inc., the operating company, holds a group of seven unpatented claims: Harold, Bob, Homestead, Ross, Extension, Cabin, and Cristie.

First known operator was the Homestead Mining Co. which, in 1939, was developing the property by an adit on the Homestead claim and by surface pits. It was also reported at that time that a 10-foot vein of high-grade silver ore had been intersected by a 115-foot crosscut. (Information supplied by owner to W.P.A. Mineral Survey, Montana, November, 1939.) It was also reported that there was a "great shattered zone" more than 250 feet wide south of the adit. This is, most likely, a reference to the 30-foot fault zone exposed underground in the main adit which was driven some years later. (See pl. 2D.) The Mining World's catalogue, Survey and Directory number for the years 1945 to 1949, reports that the Homestead Mining Co. was engaged in development work, but there is no record of production. From 1950 to 1956 the mine was inactive. In 1957 the Montana Mining Association Newsletter (January, February, March, 1957) reported that the mine and access road were being reopened by Holliday Mines, Inc. The mine has been developed intermittently since that time, and in 1961, 16 tons of ore was shipped to the Bunker Hill smelter in Kellog, Idaho. The ore contained 20 ounces silver, 2000 pounds lead, 600 pounds zinc, and had a total value of $293.

Development at the Holliday is by two adits; both of which were accessible during the summer of 1961. The upper adit was driven many years ago, but the main adit is the result of more recent work. During the winter of 1960-61 a 100-foot winze was sunk in the main adit; however, in September of 1961 the winze was flooded. Surface buildings consist of living quarters, enclosed tramway, ore bin, and shop buildings.

Veins at the Holliday mine are unique in that there is no noticeable wall rock alteration. The transverse veins, which strike N. 70° to 80° W. and dip 65° to 80° SW., though narrow, are glaringly distinctive. They are strictly fracture fillings with no sign of replacement. Milky white quartz comprises the bulk of the vein, with pods, lenses, and irregular bunches of sulfide minerals distributed throughout. One of the features that is most noticeable is the pencil-line contacts between white vein quartz and the wall rock, which is dark-olive green to greenish-grey calcareous argillite of the Wallace Formation. Vein widths range from 1 to 15 inches, but the smaller veins are usually grouped in parallel clusters so that the total or accumulated vein width at any one point is rarely less than 6 inches. The lack of alteration of wall rock is evident even between closely spaced parallel veins.

Wall rocks are thin banded and in several places display ripple marks and mud cracks so oriented as to indicate that the beds are right side up. Bedding strikes N. 25° to 45° W. and dips 9° to 25° NE. The only alteration noticed in the wall rocks is surface weathering and iron staining in the upper adit and sericitization along the massive fault zone in the main adit. Minor crumpling is evident near the major fault.

The major fault, 280 feet from the portal of the main adit, is the most intense structure in the mine. Although most of the fault zone is composed of sheared and brecciated wall rock, the fault plane proper is filled with 12 inches of clay. The fault strikes N. 45° W. and the dip appears to be vertical. Post-mineral faulting is very evident though inconsequental. Numerous small northwest-trending faults have offset the vein, but invariably the relative movement has been to the northeast. Rarely is the vein offset more than 5 feet.

Plate 2D shows the relations between the veins exposed by both adits. It appears there are either two parallel veins or that a bedding plane fault has offset the vein to the right beneath the upper adit. Evidence for or against either situation could not be found; however, it would be a relatively minor problem to test the existence of

the two-vein system with a drill hole from the short southeast crosscut in the main adit.

Vein minerals are pyrite, sphalerite, chalcopyrite, galena, and marcasite in a gangue of milky white quartz. The order of deposition is essentially as given with quartz and pyrite being the first to be deposited. Sphalerite and chalcopyrite were probably deposited simultaneously because most sphalerite contains minute exsolution blebs of chalcopyrite along crystal planes. (See fig. 7.) Most chalcopyrite, however, forms relatively large masses. All minerals with the exception of pyrite and marcasite occur throughout the vein as blebs and masses with relatively little intermingling of different species. There is very little interlocking between the major sulfides because the areas occupied by a single mineral are far larger than the combined areas of the small embayments of the other minerals at the grain boundaries. Pyrite occurs as euhedral crystals and as fragments of crystals that have been caught up in masses of other sulfides. Marcasite replaces pyrite and usually displays serrated grain boundaries where it has penetrated its victims.

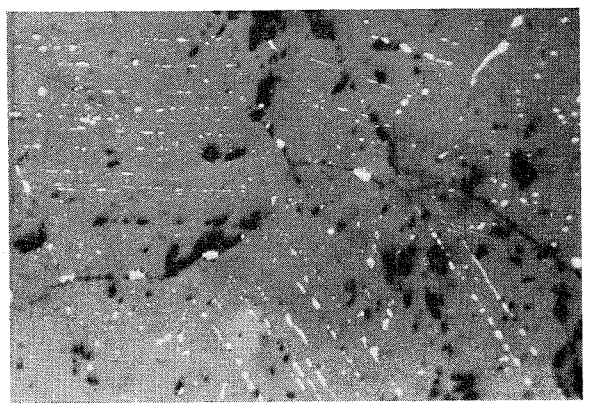

FIGURE 7.—Photomicrograph of chalcopyrite exsolution blebs along cleavage planes in sphalerite, Holliday mine.

MILLER

An abandoned prospect, known as the Miller, is about 3 miles southwest of Noxon on the Pilgrim Creek road. Two mine dumps can be seen north of the road opposite the Stover ranch or Mountain Home ranch. (See fig. 6.) The abandoned adits are about on the section line between sec. 26 and sec. 35, T. 26 N., R. 33 W.

Little is known of the early history except that a man by the name of Miller prospected and developed the property. According to local people the land occupied by the prospect is now part of the Stover ranch.

Development was by two adits which apparently were driven into the ridge in about a N. 40° W. direction. Both are caved at the portal, but from the size of the dumps it is estimated that there are about 700 feet of underground workings in each adit.

A few mineralized specimens from the dump contained quartz, chalcopyrite, copper pitch, and minor amounts of pyrite. The greatest portion of the dump is made up of thin-bedded greyish-green calcareous argillite. The argillite is fine grained, weathers brown to light tan, and displays ripple marks and mud cracks. Crystalline calcite of secondary origin fills voids and cracks in specimens of vein quartz.

PILGRIM (HOLBERT)

The Pilgrim prospect is 10.2 miles southwest of Noxon in sec. 8, T. 25 N., R. 33 W., near the head of a small creek which is a tributary to the South Fork of Pilgrim Creek. (See fig. 6.) Early descriptions of the prospect call the tributary Tobin Creek, but available maps do not name the stream.

In the late 1910's the Pilgrim Group of 6 claims was held by the Princemont Mining Co. of Idaho (The Mines Handbook, v. 8, 1918, p. 794). Later issues of the handbook indicated "no recent operations." In 1926 it was reported that the Cabinet Range Copper Mining Co. was developing the mine. This company, incorporated in Montana in 1919, was reportedly doing development work on 18 claims. The quartz vein which outcropped on surface for 2,000 feet was developed by three tunnels (adits) 200, 700, and 2,000 feet long. Copper, lead, and bismuth were present in the vein which cuts across Newland (Wallace) slates (The Mines Handbook, v. 17, 1928, p. 1059, 1060).

During the summer of 1960 one adit was accessible for 280 feet, but an extremely heavy flow of water was rapidly filling the underground workings with sand and pebbles. No mineralization was encountered in the accessible workings. Wall rock is a thin-bedded light-greenish grey slightly calcareous argillite with some thick beds of brownish-grey quartzite. The bedding strikes slightly northeast and dips 60° NW.

Sulfide minerals were very scarce on the dump, but a few specimens contained felted malachite and azurite with specks of chalcopyrite in white quartz. Calcite is abundant.

WHITE STAR (BAKER)

The White Star prospect is in sec. 4, T. 25 N., R. 33 W. Two portals can be seen on the east slope of Pilgrim Creek from the main road about half a mile southeast of the Holliday mine road junction. (See fig. 6.)

Early history of the mine is not known, and there is no record of production. The two adits (fig. 8) 95 and 340 feet long were driven in medium-thick-bedded dark-grey argillaceous quartzites and intersect and follow small 1- to 6-inch quartz veins. The quartz veins are usually

vuggy and barren except for calcite, siderite, and very minor chalcopyrite. Some of the white quartz veins are made up of aggregates of quartz crystals, some of which are 4 inches long and three-fourths of an inch wide.

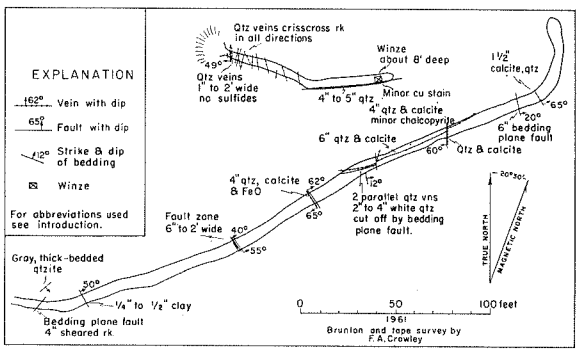

FIGURE 8.—Geologic map of workings, White Star prospect, Pilgrim Creek mining district. (Sec. 4, T. 25 N., R. 33 W.)

PLAINS DISTRICT

The Plains district is an almost indefinable area surrounding the town of Plains. Several of the district's most notable characteristics are an abundance of Prichard argillites and a lack of information. Although table 12 shows the production of 3 mines, only the Montana Premier could be located. The Montana Premier is 2 miles south of Plains; the Dog Lake mine is assumed to be near Rainbow Lake, which was formerly known as Dog Lake. The location of the Poorman mine, which produced in the early 1900's, is not known.

Averaging the totals in table 12 to give average grade would not be practical because of the large area involved and the different types of ore mined.

For the purpose of this report the Plains district embraces T. 20 N., R. 25 and 26 W., T. 19 N., R. 25 and 26 W. and the N½ of T. 18 N., R. 25 and 26 W. The northern two townships are included only because Rainbow (Dog) Lake is in this area. The southern portion is included because of the arsenic-cobalt occurrence and No. 10 Tunnel prospect, which are along the northwest side of the Clark Fork River.

Underlying almost all of the district are thin-bedded light- and dark-grey argillites of the Prichard Formation. Between Paradise and the Flathead Indian Reservation boundary the argillites are broadly folded and strike from N. 20° E. to east-west and dip from vertical to 82° NW. to 31° S. The broad folds appear to strike about north. Some of the beds are dark-grey to black quartzitic argillites. The lower Ravalli Formation conformably overlies the Prichard along the western margin of T. 18, 19, and 20, R. 26 W. Massive sills of predominantly medium-grained dark-grey to black gabbro are conformable with the bedding in the Prichard west of Plains and west and south of Paradise. A diorite sill at the Letterman mine is probably a mineralogical phase of this system of sills.

Mineralization, where noted, is always associated with or is near a sill. The Letterman veins are within 200 to 400 feet of a diorite sill. The arsenic-cobalt occurrence and the No. 10 Tunnel prospect are both in the massive sills south of Paradise, and there is a reported gold-bearing quartz vein east of Paradise in a massive gabbro sill.

Whether or not mineralization has a genetic association to the sills in the Prichard Formation, it does remain a fact that mineralization, where observed, is either in or near the intrusive bodies. Consequently, it would be advisable to direct any future mineral exploration to areas intruded by gabbro.

ARSENIC-COBALT OCCURRENCE

The Northern Pacific Railroad follows the west bank of the Clark Fork River from St. Regis to north of U. S. Highway 10-A. In railroad cuts south of Paradise in sec. 4, T. 18 N., R. 25 W., a massive fine- to medium-grained black gabbro sill is exposed. Quartz veins 2 to 6 inches wide cut the gabbro at different angles, and near several of these veins arsenopyrite is disseminated through the gabbro. Crystals of arsenopyrite up to a quarter of an inch long were observed in the rock and masses of arsenopyrite 4 to 7 inches across were apparent near the veins. The crystals diminish in size and quantity away from the quartz veins. Although small crystals of the arsenic mineral could be seen sparsely scattered throughout most

TABLE 12.—Production of gold, silver, copper, lead and zinc, 1906-49, in terms of recoverable metals, Plains district.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
1906	14	28	—	—	—	—
1933	1	2	—	—	—	—
1939	14	3	140	19	1,128	—
1940	3	—	474	—	100	—
1941	6	—	450	—	100	—
1947	8	—	17	542	—	—
1949	11	—	674	—	100	—
Total	57	33	1,755	561	1,428	—

of the gabbro sill, the mineralization is more apparent near the south contact where the gabbro abuts against black fine-grained argillaceous quartzite.

A selected high arsenopyrite sample was taken for analyses. It contained 16.55 percent arsenic, no platinum group metals, no nickel, and 0.055 percent cobalt.

Arsenopyrite is the major mineral present. It occurs as wedge-shaped crystals and as disseminated grains in the gabbro. A few rounded blebs of pyrrhotite occur within the arsenopyrite, and a later period of quartz, containing pyrite and minor chalcopyrite, cuts the arsenopyrite.

Although the mineralization is interesting from the standpoint of the gabbro intrusive and the arsenic-cobalt occurrence, it does not appear to have any economic significance.

LETTERMAN (MONTANA PREMIER)

The Letterman mine is on a tract of deeded ground comprising about 250 acres in parts of sec. 3 and 10, T. 19 N., R. 26 W., and sec. 34, T. 20 N., R. 26 W. The property, about 2 miles south of Plains, abuts, in part, the west side of Compest Creek, and is easily reached by good dirt and gravel roads. The mine is named after the man who discovered the deposit and who was instrumental in the property's early development.

First mentioned in 1911, the property consisted of 130 acres of patented ground, where, it is reported, five veins were exposed that ranged in width from a few inches to several feet. The controlling company was the Clark Fork Gold Mining Co. Fissure veins were reported in a diabase sill or dike, and bedding-plane veins were said to occur in shales. Average values per ton of ore were said to be $30 to $40 in free gold and gold tellurides along with small amounts of galena (Rowe, 1911, p. 1033).

In early 1929 the Montana Premier Gold Mining Co. was organized to operate the property, which was also known as the Plains Gold Property (Mining Truth, 1929, v. 13, no. 24, p. 24). At this time the company owned 160 acres of deeded ground and reported a 10-foot vein that was exposed for 200 feet on surface by pits and shallow shafts. Samples from 10 different locations along the vein carried $2.40 to $72 in gold and a trace to 14.46 ounces of silver with an average value of $36.80 per ton. A new tunnel was planed to intersect the series of veins at a depth of 200 feet (Mining Truth, 1929, v. 14, no. 1, p. 27). At about 430 feet the adit level intersected the Fisher vein, and drifts were run along the vein to the southeast and northwest (The Mining Journal, 1929, v. 13, no. 6, p. 44, 45).

In 1932 C. L. Wickstrom leased the mine and planned to extend the adit level (Mining Truth, 1932, v. 17, no. 17, p. 4). However, in 1939 the Mining Journal (v. 22, no. 18, p. 26) reported that the Montana Premier Gold Mining Co. was again operating the mine. In 1950 Trauerman and Reyner (p. 92) listed the company and reported that the mine was last operated in 1940.

Principal development at the Letterman is by a 470-foot crosscut adit which intersects a massive fault zone at 430 feet. Drifts on either side of the crosscut follow the main structure an accessible distance of 280 feet. The northwest and southeast ends of the drift are caved, and a winze on the ore body is filled with water. (See fig. 9.) Other prospect pits and shallow workings were in disrepair in 1961.

A massive fault that trends N. 32° W., and contains the ore shoot, cuts thin-bedded dark-

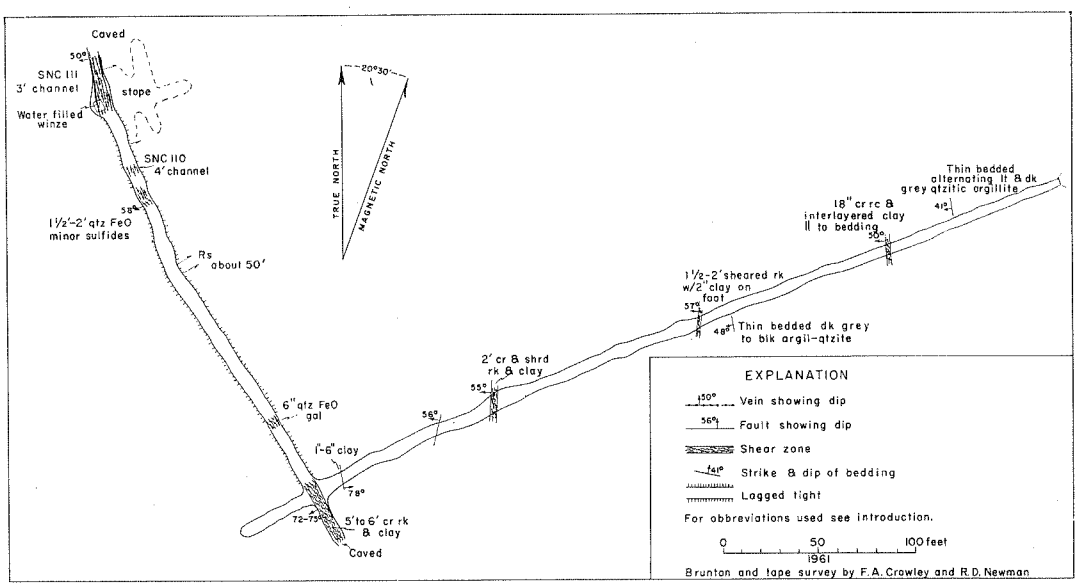

FIGURE 9.—Geologic map of workings, Letterman (Montana Premier) mine, Plains mining district. (Sec. 3, 10, and 34, T. 19 and 20 N., R. 26 W.)

TABLE 13.—Analyses of samples, Montana Premier mine.

Sample No.	Width	Gold (oz.)	Silver (oz.)	Copper (%)	Lead (%)	Zinc (%)	Arsenic (%)
SNC-110[1]	4 ft.	none	none	0.03	0.35	none	none
SNC-111[2]	3 ft.	2.08	2.30	0.08	9.35	none	none
SNC-112[3]	4 ft.	0.04	0.55	0.05	4.10	none	none

1—Four-foot channel sample about 50 feet from the caved end of the northwest drift.
2—Three-foot channel sample across the vein at the caved end of the drift.
3—Four-foot channel sample across the vein in a small intermediate drift about 10 feet above SNC-111.

grey to black argillites of the Prichard Formation. This structure is known as the Fisher vein. The fault, which dips 72° SW., is about 6 feet wide where the crosscut intersects it and is composed of crushed fragments of wall rock and fault clay. About 160 feet northwest of the point of intersection the fault is filled with vein quartz that becomes richer in sulfide minerals as one approaches the caved end of the drift. The ore shoot dips less steeply (50° SW.) than the fault and strikes about N. 15° W. The location of the mineralized zone was probably controlled by this change in strike and dip.

The opening which allowed the placement of the ore body, in this case, could have been formed by two possible ground movements, a reverse fault or a strike fault. A reverse fault in which the footwall has moved down with relation to the hanging wall would create an opening along that portion of the fault where the dip is less steep. An opening would be created along a strike fault, in this case, when the footwall moved southeast with relation to the hanging wall. The actual movement was probably a combination of the two with the footwall moving downward and to the southeast.

It can be calculated that the line of intersection between two planes which correspond to the clay-filled portion and the ore shoot has a bearing of about N. 45° W. and plunges 32°. Therefore, the ore shoot rakes to the northwest at an angle of 41° in the plane of the ore shoot (fig. 9), assuming that the strike and dip of fault and ore shoot do not change abruptly. Future development should, therefore, be directed downward and to the northwest along the shoot. Other locii of mineralization may also be present in the near-parallel faults that can be seen in the crosscut adit (fig. 9). It may be that a wrinkle in these smaller faults would parallel the wrinkle in the larger mineralized fault, and it is possible that such has occurred because early reports on the property mention the existence of five parallel veins. If a certain degree of parallelism exists between a series of faults, one might expect additional ore shoots that also rake to the northwest. A fine-grained diorite sill (?) is exposed at the portal of the adit. Only the southern portion of the sill was observed and its exact relation to the bedding could not be determined.

Metallic gold and galena are the chief economic minerals in the Fisher vein. Although the native gold was not observed in polished sections by the writer, it was mentioned by McCarty (1937) who noted that many particles of gold were larger than 40 mesh. He describes a blue quartz as being the predominant host for the gold which has a fineness of 842 (1000 fine is pure gold).

Galena, cerussite, and siderite are prominent near the caved end of the northwest drift. The galena is medium grained and occurs as pods up to 1 foot long and as small veinlets about 1 inch wide through grey to reddish iron-stained quartz. Cerussite crystals fill vugs. Some of the vugs are 4 to 6 inches across and contain crystals about half an inch long.

The analyses of three channel samples taken in September 1961 are shown in table 13. Sample numbers correspond to numbered locations on figure 9.

NO. 10 TUNNEL

Just south of the No. 10 Tunnel on the Northern Pacific Railroad between St. Regis and Paradise there is a small prospect adit. The adit is almost directly west and across the river from the Harwood House in sec. 9, T. 18 N., R. 25 W.

A narrow 3- to 12-inch bedding-plane vein that strikes N. 30° W. and dips 37° SW. has been intersected at the end of a 20-foot adit. The vein parallels bedding of light-grey quartzitic argillite and is composed of milky quartz with scattered pods of galena, pyrite, native silver, and sphalerite.

A 10-inch sample across one of the richer-looking spots on the vein contained 11.1 percent lead, 0.02 ounce gold, and 4 ounces of silver per ton.

PROSPECT CREEK DISTRICT

The drainage of Prospect Creek and its tributaries enclose this district, which also has been known as the Burns and Mountain House mining districts.

Perhaps the earliest lode claims in the County were staked along this creek, for it served as one of the main thoroughfares to the Coeur d'Alenes during the early 1880's and was known as the Murray trail or the Thompson Pass trail. Gold seekers from all parts of the country reached the Coeur d'Alene gold fields by way of Thompson Falls up Prospect Creek and over Thompson Pass. The road, which was opened in the spring of 1884, was handled as a toll road with charges of $3 for a 2-horse load.

According to the Geologic Map of Montana (1955) the regional structure is not complex.

Prospect Creek cuts east-west through a nearly north-south trending anticline. Prichard Formation sediments, sericitic grey thin-bedded argillites, are exposed in the center of the anticline with the heterogeneous argillites and quartzites of the Ravalli Formation exposed on either side. On the eastern flank of the anticline the predominantly calcareous argillites of the Wallace Formation are exposed.

The local picture of the geology is more complex, but detailed geologic mapping would be necessary to show the complexity. Near and in most of the prospects faulting is very evident, and sills and dikes too small to be shown on the State map can be seen at the Montana Standard mine and near the Antimony mines. A large fault, the Thompson Pass fault, cuts Ravalli Formation rocks at the pass of the same name and follows Prospect Creek eastward for an unknown distance. Folding, minor to the large anticline, is evident on a small scale in numerous road cuts along the creek and at many of the prospects.

No mines were active in the district during the summer of 1961, and the last known operation was that of lessors at the Montana Standard in 1960.

From 1908 through 1958 the Prospect Creek district was credited with a production of 3,585 tons of ore from which were recovered 39 ounces gold, 8,348 ounces silver, 1,660 pounds copper, 448,497 pounds lead, and 207,000 pounds zinc. Total value of production during the same period of time was $93,361 or an average value of $26.04 per ton. It is evident from these figures that the principal metals were lead, silver, and zinc, and so it appears as one examines the mineral assemblages of the various mines and prospects. With the exception of the Antimony Gulch mines and the one gold property (Shamrock), most mines and prospects contain galena and sphalerite and are notably poor in silver minerals. From the above figures it can be seen that the average silver content of the ores is only 2.33 ounces per ton. Tetrahedrite, which is the silver-bearing mineral in many surrounding areas, is not found abundantly in the district. The lack of abundant silver minerals plus an abundance of zinc minerals, which are not economical to mine at present metal prices and which were also not economical to mine during many former years, are but two of the reasons for the lack of large-scale production. The narrow veins and erratic ore shoots of many prospects were, undoubtedly, discouraging to both present- and early-day miners.

Pyrrhotite, a high-temperature mineral, is found with lead and zinc minerals in most veins. As in other districts of the County, the presence of pyrrhotite foretells a lock of tetrahedrite, and consequently low silver values are the rule.

Placer production from the district is insignificant, as only two troy ounces were produced from 1906 to 1958.

ANTIMONY MINES

Near the head of Antimony Gulch there is a group of antimony-bearing quartz veins. Numerous patented and unpatented claims cover parts of sec. 16, 17, 19, 20, 21, 29 and 30, T. 21 N., R. 31 W., and outcrops and float of antimony ore are evident over much of the area. One group of patented claims is owned by Mrs. Nettie Peek, Missoula; First State Bank, Thompson Falls; and John R. Barto, Great Falls. They are the St. George, Elda, Mammont, Excelsior, Midday, Favorite, Morning View, and Station millsite. (See fig. 10.) Almost all lie wholly within sec. 20. Another group of four patented claims, the Black Jack, Ellis, Eureka, and Black Jack millsite, are owned by John R. Barto. The Eliza and Little Comet, both of which are cut by the section line between sec. 16 and 17, are owned by Knute Kirkeberg who also holds the Norway, Babbit, Midas, Stibnite, and Mowich unpatented claims.

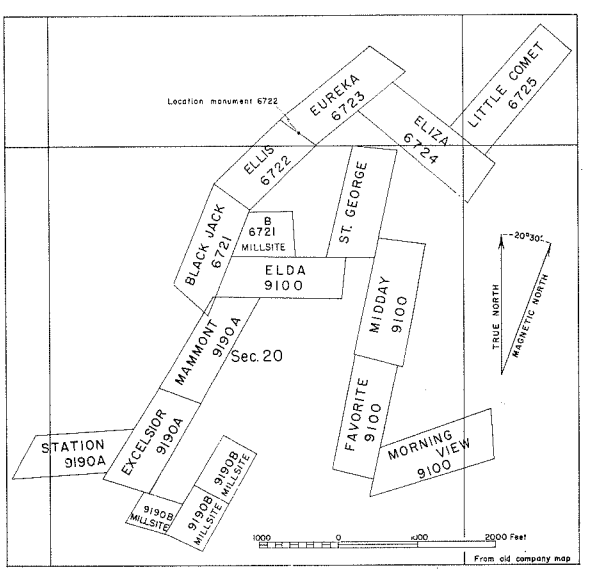

FIGURE 10.—Map of patented claims, Stibnite Hill, Prospect Creek mining district. (T. 21 N., R. 31 W.)

According to O'Leary (1907, p. 284) the first discovery of antimony in this area was in 1884 during the period of time when Prospect Creek and Thompson Pass were the routes followed to the Coeur d'Alenes. This early description of the antimony veins describes them as blanketed ledges of low dip containing 12 to 60 percent antimony, 8 to 30 ounces of silver, and $0.90 to $17 per ton in gold. Lead and arsenic were not described as being present. At that time development had not been extensive, but ore bodies 300 feet in length were noted.

O'Leary describes the early operations as follows:

"After 3 carloads of assorted crude ore had been sold in the East at a very small profit, the owners determined to treat the production on the grounds. A furnace was erected which reduced the antimony to an oxide assaying 80% and upward. The plant was small producing from 1,000 to 1,500 pounds oxide in 24 hours using a quarter of a cord of wood as fuel. The oxide was collected in sheet iron flues and in two chambers situated about 200 feet apart on the hillside. Three cars of the oxide were sold at a good profit before operations were suspended."

The properties were idle until World War II gave impetus to their development. Two mines produced antimony ore in 1940. In 1941, 4 different mines, the Coeur d'Alene, Eureka & Ellis, Interstate, and Stibnite Hill, produced. Four mines also have records of ore shipments in 1942. The Coeur d'Alene did not ship, but an unnamed mine took its place. No production is then recorded until 1951 and 1953 when the Stibnite Hill mine again recorded a small amount of production.

Recorded production figures show a total tonnage shipped from the area between 1940 and 1953 at 532 tons, which contained 137 tons of antimony.

The productive properties are listed above with the owner-operator.

Mine	Year	Owner-Operator
Coeur d'Alene	1941	J. H. Burroughs
Eureka & Ellis	1941	John R. Barto
Eureka & Ellis	1942	Sunshine Mining Co.
Interstate	1941	J. H. Burroughs
Interstate	1942	Interstate Antimony, Inc.
Stibnite Hill	1940-42	Thomas & Snider
Stibnite Hill	1942	Sunshine Mining Co.
Stibnite Hill	1951-53	B. F. Cooper
Unknown	1942	Harry E. Hickey
Unknown	1942	W. L. Grill

During the past, numerous adits and prospect pits have been opened along the antimony veins, but during the summer of 1960 only two major adits, the Barto and Babbit and several very short adits, were accessible. Three hundred and forty feet of the Barto adit is accessible, but a cave-in was encountered near the raise at its far end. (See fig. 11.) The raise connects the main adit with shallow workings at the surface. The Babbit adit is open its entire length of 260 feet. The veins in both adits have been stoped along their thicker portions.

All mineralization observed in the antimony district is in the form of fissure fillings and some replacement by metallized quartz veins in shales of the Prichard Formation. The veins range in width from 5 feet to less than one inch, and metallic content also differs considerably along the vein. Most veins strike northeast and dip at low angles to the northwest.

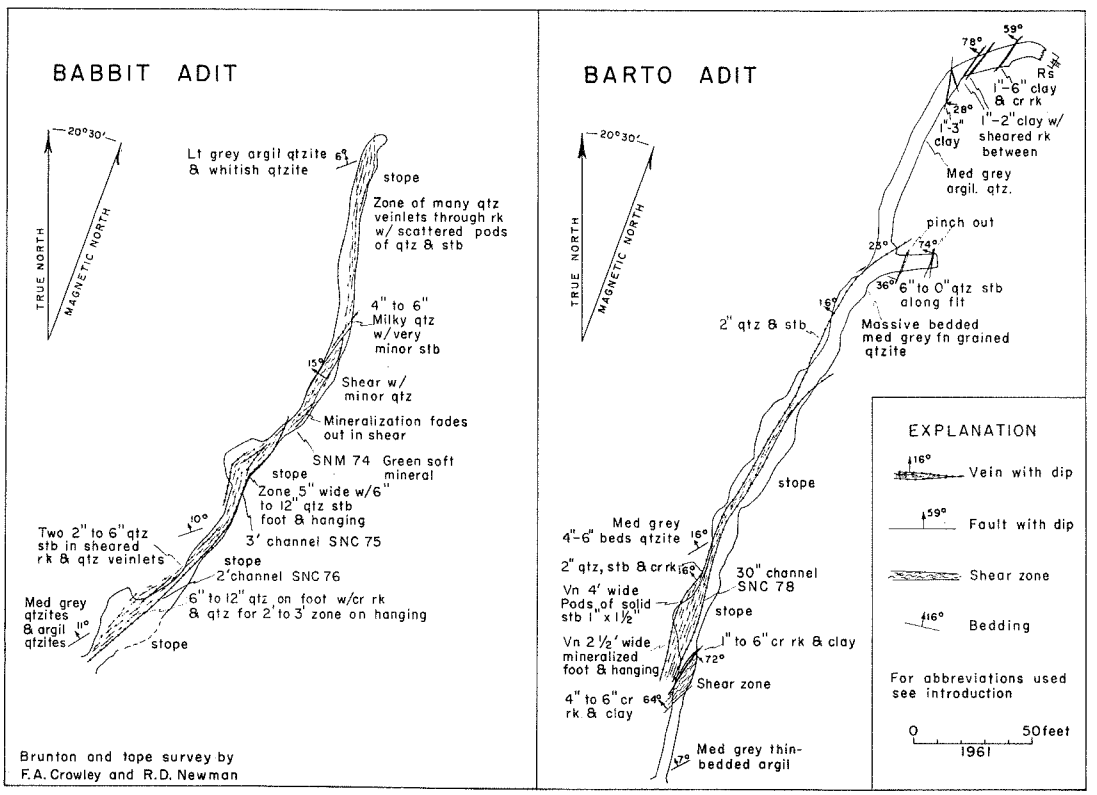

FIGURE 11.—Geologic map of Babbit and Barto adits, Stibnite Hill, Prospect Creek mining district.

In part, the veins appear to be bedding-plane veins, but some are crosscutting. In the underground workings of the Babbit, the veins appear to follow bedding planes, but on close examination the veins are slightly crosscutting. The intersection of vein with bedding planes is imperceptible in the adit.

Little displacement by faulting is evident, but some movement after mineralization is displayed by the wrinkling of stibnite and quartz layers between more competent shale beds. A large fault near the portal of the Barto adit (fig. 11) apparently cuts the vein as does a steeply dipping fault (81° SW.) at the Little Comet which is about 1,500 feet northeast of the Babbit.

Wall rocks of the Prichard Formation are for the most part thin-bedded, medium-grey argillite with some thick-bedded, medium-grey, fine-grained quartzite. The Prichard Formation in this area forms the exposed core of a slightly northwest-trending anticline. Ravalli Formation rocks surround the Prichard on all sides. From the predominance of northeast-trending veins in the area, it seems likely that the faults which controlled localization of ore bodies were formed as the result of east-west forces. However, the near parallelism of the veins to bedding planes suggests also that the faults are the result of adjustment along beds caused by folding.

Minerals present in the veins are quartz, stibnite, pyrite, sphalerite, and arsenopyrite. Quartz and stibnite are the most abundant with the other minerals occurring in minor quantities. Quartz surrounds brecciated fragments of wall rock in some portions of the vein and serves as a host for other sulfides. Stibnite most often occurs as narrow 1-inch to 6-inch veins or elongate lenses throughout the over-all vein structure. It may form masses or fill vugs as tiny hair-like crystals. Crystal-lined vugs are quite striking, but the great fragility of the crystals makes their beauty short lived. Arsenopyrite assumes its crystal outline in most cases whereas pyrite usually occurs as rounded blebs and irregularly shapped masses. The reddish-brown somewhat transparent sphalerite occurs as scattered grains through massive stibnite and quartz.

Antimony veins almost identical in occurrence with those in Antimony Gulch are found on Pine Creek, south of Kellogg, in Shoshone County, Ida. They have been described by Umpleby and Jones (1923, p. 121). The Idaho antimony veins are fissure fillings and replacements in Prichard Formation rocks and contain an almost identical suite of minerals, i.e., quartz, siderite, stibnite, pyrite, and sphalerite. Arsenopyrite was not noted, but chalcopyrite occurs sparingly. The veins have widely divergent strikes and dips, and in some prospects the vein conforms with the

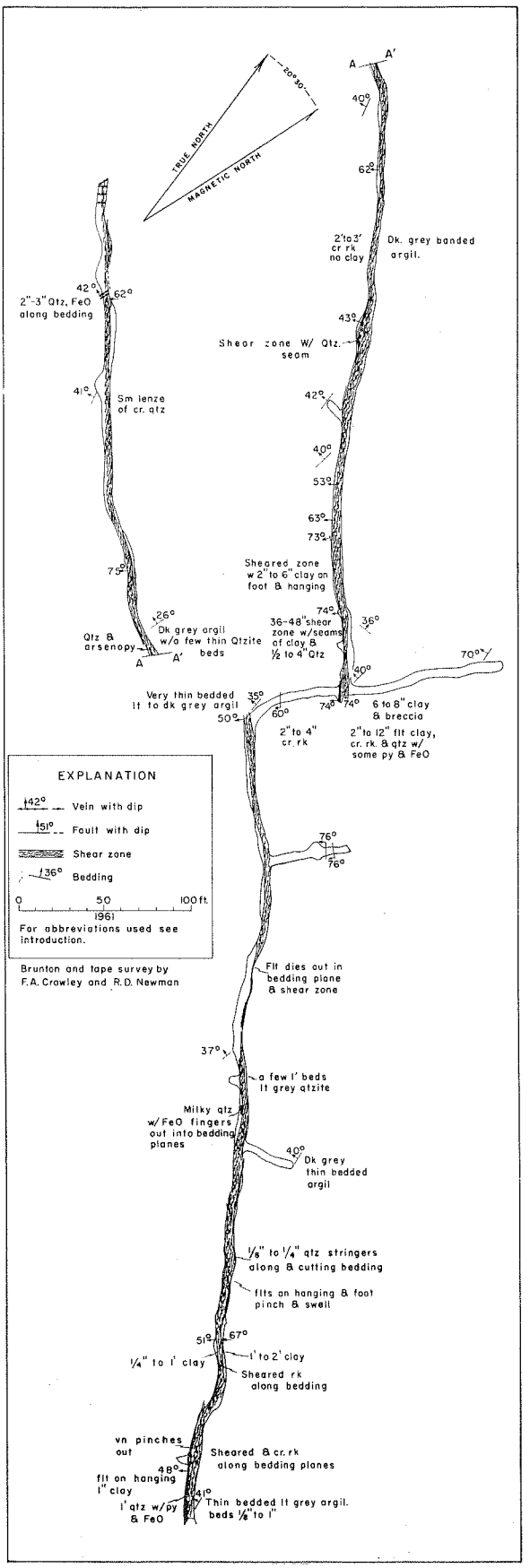

FIGURE 12.—Geologic map of workings, Arlington prospect, Prospect Creek mining district. (NW¼ Sec. 28, T. 21 N., R. 32 W.)

bedding of the footwall, but it was noted that hanging-wall beds are crumpled and contorted.

ARLINGTON

Near the Montana-Idaho divide and accessible by about 2 miles of Forest Service trail is the abandoned Arlington prospect. It is in the unsurveyed NW¼ sec. 28, T. 21 N., R. 32 W., on the north slope of Glidden Creek. The Glidden Creek trail leaves the Thompson Pass fork of the Prospect Creek road about 5.3 miles above the junction to Burke, Idaho.

Discovery of the Arlington must have been made in the early 1900's for in 1908 the Minerals Yearbook noted that the operators of the prospect were developing some lead, silver, and copper ore, and that the first section of a 5-stamp mill had been completed. According to the Copper Handbook (1909, p. 337) the Arlington Mining Co. held 30 claims in the Mountain House unorganized mining district. Assays of 6 percent lead were reported. The company in 1910 reportedly was holding 20 claims and was said to have traced a galena-bearing ledge for 6,000 feet on the surface. Two tunnels (adits) had been driven on the property. The upper tunnel was 175 feet long and contained a 3-foot vein of "good concentrating galena," and the lower, 900 feet long, had intersected a 10-inch vein containing copper, lead, and silver (The Copper Handbook, 1910-11, p. 372). A lawsuit at this time on a promissory note apparently stopped operations for good because subsequent issue of the Copper Handbook and its successor the Mines Handbook did not contain mention of additional work. The company's listing finally lapsed into the inactive list, and there are no records of production.

Several early-day drilling machines were noticed on the dump of the main adit. They contained the words: "Wood Drill Works, Patterson, New Jersey."

In the summer of 1961 there were 1,300 feet of accessible workings in the lower adit (fig. 12), but the upper adit was caved at the portal. Between the two, surface pits had exposed portions of a quartz vein. The lower adit has traced two nearly parallel shear zones. Both zones strike about N. 35° W. and closely follow in dip the bedding planes of the thin-bedded argillite wall rock. Near the portal the fault zone follows the bedding planes, but farther into the mountain the faults cross the bedding.

Mineralization is very sparse, consisting of a few quartz pods and lenses within the shear zones and minor 1- to 2-inch quartz veinlets. The surface pits expose the most intense mineralization. Here a 2-foot quartz vein which strikes about N. 13° W. and dips 64° SW. contains a few pods of sulfide minerals. Quartz, pyrite, galena, and sphalerite and chalcopyrite are megascopically visible. Pyrrhotite and a moderately interlocking texture between galena and sphalerite were noticeable only with the aid of a microscope. The pyrrhotite occurs predominantly as minute (about 0.05 mm. wide) rounded blebs in sphalerite, at the grain boundaries. The sphalerite inclusions in galena are rounded whereas the galena inclusions in sphalerite are usually of irregular shape. Most abundant of the sulfides are sphalerite and galena; the other sulfides occur in minor quantities.

BULL FROG

Near the head of a small eastward-flowing tributary to Summit Creek is a prospect called by some local people the Bull Frog. One adit and the beginnings of another are on the southeast slope of a small basin at an elevation of about 5,600 feet in the unsurveyed NW¼ sec. 9, T. 20 N., R. 32 W. The adits are only half a mile west of the ridge crest that separates Sanders County, Mont., from Shoshone County, Ida. The prospect is approximately 1 mile by Forest Service trail from the first switchback as one approaches the crest of the ridge on the road from Thompson Falls to Burke, Idaho.

The early history of the property and the proper name are not definitely known, but the 1916 issue of the Mines Handbook (p. 1042) describes a Silver Tip Mining Co. whose prospect was said to be just over the Montana line north of the Snowstorm mine in Idaho. The Bull Frog is the only prospect known in that area. There is no record of production.

Development is by one 580-foot adit and the beginnings of another adit about 10 feet long. (See fig. 13.) The main adit has been driven into the hillside in a N. 75° W. direction. It follows a weakly mineralized shear zone. A winze of unknown depth 70 feet from the portal is water filled.

Mineralization in the main adit is sparse. The most highly mineralized zone is a 2½-foot vein, which follows a fault plane for about 60 feet before pinching out on both ends. Several crosscuts at this point reveal many parallel faults and of special note is the 24- to 36-inch fault in the southwest crosscut. It seems likely that where there are a series of parallel faults, mineralization will follow relatively clay-free fault planes. The main fault along which the adit is driven contains much clay up to the point where the vein begins; consequently, most of the movement at this point must have been taken up along the parallel faults and allowed an opening to form in the main fault. A few small lenses and fragments of vein quartz with minor amounts of sulfides can be seen scattered through the N. 75° W. trending shear zone. All major structures dip to the southwest, the vein 81° SW., the main fault 70° to 76° SW., and the minor faults 30° to 88° SW. Only one minor fault dips northeast.

In the short upper adit a 6-inch vein contains abundant pyrite and galena in quartz. The vein strikes N. 80° W. and dips 83° SW.

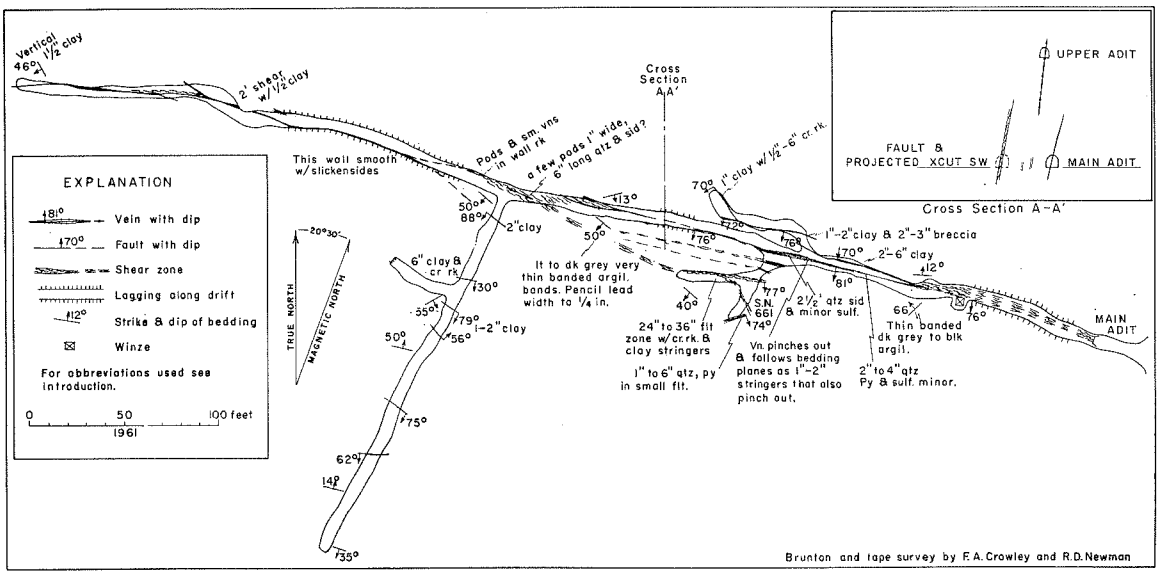

FIGURE 13.—Geologic map of lower adit, Bull Frog prospect, Prospect Creek mining district. (NW¼ Sec. 9, T. 21 N., R. 32 W.)

Country rock between the two openings is a thin-bedded, crinkly, brown-stained argillite containing numerous square to rectangular voids left by the solution of pyrite crystals. Wall rock in the main adit is a thin-bedded, light- to dark-grey argillite which looks much like Prichard Formation rocks, but which is depicted as Ravalli Formation on the Geologic Map of Montana (1955). It is, most likely, an argillaceous facies of the Ravalli Formation.

The mineralogy of the quartz vein in the main adit is of little significance for it contains only quartz with some siderite and a few scattered crystals of pyrite. Mineralogy of the small vein in the upper adit is more diverse. Quartz, pyrite, pyrrhotite, siderite, galena, iron oxides, and a mineral whose optical properties coincide closely with boulangerite are found in the vein. Quartz and siderite, as gangue minerals, are the most abundant. Pyrite and pyrrhotite are minor constituents with pyrite occurring as scattered crystals and the rarer pyrrhotite as very small rounded grains in galena. The only economically significant mineral is galena which occurs as irregular masses up to 3 or 4 inches wide. The lead sulphantimonide, boulangerite, is erratically scattered through galena as extremely tiny blebs which seldom exceed 0.06 mm. in length and 0.03 mm. in width.

Structural conditions at the Bull Frog may be more complex than first meets the eye. Although visible mineralization is rather discouraging, the general structural relations may offer a clue not only to the nature of ore deposition at this prospect, but it may be a worthwhile example to keep in mind concerning other metallic ore deposits in Beltian rocks.

Cross section AA (fig. 12) shows that the projection of the small vein in the upper adit matches a rather insignificant looking shear zone in the main adit. The small vein is apparently not connected with the quartz vein below. From this we might infer a haphazard system of ore shoots localized along any of a number of closely spaced, but not quite parallel, fault planes. The localization of an ore shoot in one fault plane is probably controlled by the available opening or conversely is prevented by the constriction of other nearby faults with heavy fault clay.

Prospecting for ore shoots in this or similar situations is risky. A drift along one fault may intersect a mineralized zone, but it may also miss or bypass an ore shoot in a nearby fault. One possible method of finding ore shoots on either side of a main underground working would be the systematic testing of both walls by short crosscuts or long hole drills. Where ore shoots tend to be short in their horizontal direction the walls should be tested at short intervals. Larger ore shoots would require less frequent tests. However, this method is obviously not infallible for the erratic nature of the ore shoots will probably apply to the vertical dimension of the faulted zone as well as to the horizontal.

COOPER CREEK MINING COMPANY

High on the divide between Montana and Idaho near the head of Cooper gulch and about 1 mile west of Cooper Pass are 3 caved and abandoned adits. Some of the early day workings can be seen on either side of the Thompson Falls-Burke, Idaho, road at a power line crossing. More precisely the adits are in unsurveyed NE¼ sec. 5, T. 20 N., R. 32 W.

Some confusion exists as to the proper name of the old prospect. Early issues of mining magazines have briefly described a prospect at the head of Cooper gulch and in each case naming the same persons as officers of the different companies. Three different company names were given: Copper Creek Mining Co., Neglected Mines Co., and Cooper Creek Mining Co. All three were mentioned during 1928-29. (The Mining Journal, 1928, v. 11, no. 23, p. 40 and Mining Truth, 1929, v. 13, no. 20, p. 24.)

In 1929 The Mining Truth (v. 14, no. 7, p. 24) gave the following account:

"Drift extended about 100 feet on ledge which is reported to be almost full width of drift and shows high mineralization. A recent assay secured from a hand sample (picked specimen) contained 41 percent lead and good silver values.

"Holdings of the company comprise six claims, Monte Cristo and King group on Cooper Creek."

A similar statement in The Mines Handbook (1931, p. 1299) is headed Copper Creek Mining Co. and gives the location as Copper Creek. No production has been recorded since 1902 for a property by this name. Last operation was in 1933 (Gilbert, 1935, p. 69).

HAPPY BOY

Two adits have been driven on narrow quartz veins at the Happy Boy prospect in NW¼ sec. 33, T. 21 N., R. 31 W. The veins which are only 2 to 3 inches thick strike N. 55° W. and dip 65° SW. Wall rock, which strikes east-west and dips 35° S., is medium-grey, thick-bedded quartzitic argillite of the Prichard Formation. The upper adit is about 275 feet long and the lower about 150 feet.

IRON DAISY

The Iron Daisy mine is on Daisy Creek about 1 mile south of Prospect Creek and about 11 miles from Thompson Falls. A block of 5 lode claims and 2 millsite claims cover parts of sec. 2 and 3, T. 20 N., R. 31 W., and sec. 36, T. 21 N., R. 31 W. Records in the County Clerk and Recorder's office at Thompson Falls list a one-third interest for William and Margaret Marr, Russel C. and Eva L. Barlow, and Lucille M. Barlow on the Defiance, Rocket, Tunnel, Iron Daisy, and Snapshot quartz lode mining claims and on the Tunnel and Iron Daisy millsite claims.

In 1924 the property was being developed by the Iron Daisy Mining and Milling Co., which had been owners for 5 years. It was also mentioned that the mine had been worked intermittently for 30 years (The Mines Handbook, 1924, p. 1224).

In 1927 the mine was taken over on lease by the Princess Gold Mining Co. Ore from a vein 8 inches to 5 feet wide was reported to bring $40 per ton at the Bunker Hill smelter. Gold, silver, lead, and zinc were constituents of the ore (Mining Truth, 1927, v. 12, no. 1, p. 32).

A mill was erected at the mine in 1928, and in 1929 it was reported that a sizeable tonnage of mill ore had been blocked out. A test run through the mill recovered a high percentage of lead, over 30 ounces of silver, and a fraction of an ounce of gold. Assays on ore samples were said to run $18 to $52 per ton in metals.

In 1931 the Mines Handbook (p. 1350) described the mine as comprising 7 patented claims. A fissure vein in quartzite was said to dip 42° and contain an ore shoot 150 feet long. Development at that time was by 3,000 feet of tunnels, and the depth of workings was 100 feet. A large tonnage of ore was reportedly blocked out that assayed 15 percent lead, 6.8 ounces of silver, and $3.90 in gold.

The Thompson Falls Mining Co. was to resume work on the Iron Daisy in the spring of 1936. At that time the mine was reported to be 700 feet deep and was developed by a shaft and tunnels (The Mining Journal, 1936, v. 19, no. 21, p. 19). In 1935 the Thompson Falls Mining Co. was listed by Gilbert (p. 70) as having 8 patented claims enclosing 158.5 acres and 2 millsites totalling 9.5 acres. Development included a 60-foot shaft, 4 adits 200 to 1,800 feet long.

During the summers of 1960 and 1961 the mine was inaccessible. The mine dumps were covered with fine-grained, medium- and dark-grey banded argillite of the Prichard Formation. Much milky white quartz was seen on the dumps. Some of the quartz contains clusters of the sulfide minerals—galena, sphalerite, and pyrite. Microscopic examination revealed that galena is the most abundant mineral followed in quantity by pyrite, sphalerite, arsenopyrite, chalcopyrite, tetrahedrite, and jamesonite. Pyrite fragments, earlier than the galena, are scattered through the lead sulfide host. Tetrahedrite, jamesonite, and arsenopyrite are usually included in the galena but sphalerite occurs, most often, as individual rounded grains in the quartz gangue. A slight amount of interlocking between galena and sphalerite and between sphalerite and chalcopyrite is present.

TABLE 14.—Production of gold, silver, copper, and lead, Iron Daisy mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)
1923	6	1	40	—	1,699
1926	2	1	30	—	1,374
1930	50	5	50	60	150
Total[1]	58	7	120	60	3,223

1—Average grade calculated from the above totals is 0.12 ounce gold per ton, 2.07 ounces silver per ton, 0.05 percent copper (1930 production), and 2.77 percent lead.

Unlike the ores of its nearby neighbor (Montana Standard) the Iron Daisy ores, from the few samples observed, contain no pyrrhotite and appear to contain a greater amount of tetrahedrite. It may be that the vein at the Iron Daisy was

formed at lower temperatures than the vein at the Montana Standard. However, not too much faith can be placed on the examination of a few dump samples.

Three years of production are recorded for the mine. (See table 14.)

MONTANA STANDARD

From the standpoint of quantity of metals produced the Montana Standard has been the most productive mine in the Prospect Creek district. Easily accessible, the mine is about 11 miles west of Thompson Falls via the Prospect Creek road. According to the records in the County Clerk and Recorder's office at Thompson Falls, the Montana Standard Mining Co., Ltd., is the owner of patented claims comprising 24 acres in sec. 35, T. 21 N., R. 31 W., and 163 acres in sec. 25, T. 21 N., R. 31 W.

Although the discovery of mineralization at the Montana Standard must have been in the late 1890's or early 1900's, the earliest mention of the property came in August, 1905 when the Mining and Scientific Press (p. 146) reported that a flume was being constructed to carry water from Crow Creek (1 mile west) to the mine. Water power was to be used to drive a compressor. A No. 3 crosscut tunnel, driven by hand, was being extended to intersect the ledge at a depth of 800 feet. Development work was continued through 1906, and in the July 20, 1907 issue of the Mining World (p. 121) it was reported that a wide ore body carrying lead and silver was intersected. Ownership of the Montana Standard Mining Co. was held by "Pittsburg parties". In 1908 the company was listed in the Copper Handbook (v. 8, p. 974). A list of officers and directors was given, and it was reported that the company was capitalized for $1,000,000. Plans for the erection of a concentrating plant at the mine and the shipment of a test lot of ore to a smelter were reported in the Mining World (1909, p. 479). Although there is no record of production until 1939, the Copper Handbook (1910-11, p. 1206) announced that 5 carloads of ore netting about $64 per ton were shipped to the Tacoma smelter. Development at that time was by 3 tunnels, the longest being 1,800 feet long. It was also mentioned that the company held 9 claims and that 3 veins were exposed, but only two had been prospected. One vein was said to contain 6 to 8 feet of concentrating ore.

The mine was apparently shut down after 1911 because no further mention could be found of the mine or company until the Mining Journal (July 15, 1937, p. 30) reported that operations were being resumed on 13 patented claims. Production was reported in 1939 and 1940 (table 15), but then, because of World War II, activity ceased.

In 1954 the Minerals Yearbook contained the following paragraph:

"Prospect Creek (Burns). — Lead-zinc ore milled at the Golconda mill near Wallace from the Montana Standard mine operated by the Montana Standard Mining Co., Ltd., totaled 419 tons. Sixty-two tons of lead concentrate and 50 tons of zinc concentrate were produced at the mill, and 8 tons of lead-zinc ore were shipped direct to the Bunker Hill smelter. The property, which was reopened by the company in the spring of 1953, has a history of production dating back to 1902."

Shipments of ore were made to the mill during 1955, 1956, and 1957. In 1957 it was reported that the Hecla Mining Co. of Wallace, Idaho, planned to develop the property, but apparently the option was dropped because the only recent activity at the mine was that of lessors during 1960.

Development at the Montana Standard is by 3 adits and a winze level. Adit No. 1 (pl. 3) is at an elevation of about 3,100 feet above sea level. Adit No. 2 is about 400 feet above No. 1, and adit No. 3 is about 180 feet above No. 2. The 3 adits have been driven in a southwesterly direction into the hill slope south of Prospect Creek. From bottom to top the adits are 1,800, 600, and 100 feet long and each intersects the vein. The winze level is about 45 feet below the level of adit No. 1. The vein has been stoped upwards about 100 feet and down to the winze level where the vein shows the greatest width. (See pl. 3.) Surface facilities consist of living quarters, ore bins, and roads to adits 1 and 2. All 3 adits were open during the summer of 1961, but an examination was not made of the longest adit because of bad air.

Adit No. 1 is a long crosscut which intersects the vein about 1,560 feet from the portal. At this point a number of small ½- to 6-inch parallel veins cut light-colored quartzite with some interbedded greenish-grey argillite. The veins strike N. 68° to 78° W. and dip 46° to 60° SW. Several

TABLE 15.—Production of gold, silver, copper, lead, and zinc, Montana Standard mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
1939	113	—	939	—	54,489	—
1940	7	—	138	—	6,440	—
1954	427	1	1,800	400	99,700	53,600
1955	630	1	1,914	400	118,700	63,000
1956	1,009	1	1,773	400	101,700	41,600
1957	1,004	1	999	400	63,100	48,800
Total	3,190	4	7,563	1,600	444,129	207,000

of the parallel veins join above the sill-level making combined widths that range from 6 to 12 inches. Plate 3 shows that a major northwest-striking fault has offset the western part of the vein to the north about 30 feet. The mineable ore shoot is about 60 feet long, but there is not sufficient data available to foretell its dip length or direction of rake. Although the vein structure continues east and west beyond the ore shoot, sulfide mineralization becomes less abundant.

Mineralization in adits 2 and 3 is irregular in strike and in metal content. Faulted segments of the vein in adit 2 strike N. 34° to 45° E. and dip 53° SE. In the upper or No. 3 adit the much faulted vein strikes N. 50° to 80° E. and dips 34° to 55° SE. Veins in the upper 2 adits have very irregular metal content. Lenses and pods of sulfide minerals are scattered through vein quartz, and rather than one continuous vein, there are in many places irregular small veins joining and splitting or anastomosing through the wall rock. One vein may pinch out only to be replaced by several others a few feet farther on, or a lens of quartz and sulfide minerals may pinch out completely leaving only fault clay along the structure for several feet.

Although the strikes of veins as exposed in the 3 adits range from NW. to NE. and could suggest different systems, it appears there is a single vein or at least all veins belong to one mineralized zone that has been extensively faulted. Dips project rather closely from one level to the other. Mineralization is identical plus the fact that only one system of veins (northwest- or northeast-striking) is evident at one level. If there are two systems, northwest and northeast, the two are not exposed together in a single horizontal plane.

Sphalerite, galena, and pyrite are the most abundant sulfides that are megascopically visible. Quartz is the dominant gangue mineral, and chalcopyrite occasionally occurs as visible grains. Evident only with the aid of a microscope are tiny blebs of pyrrhotite, irregular grains of marcasite, and scattered crystals of arsenopyrite. The last three sulfides are not rare, but because of their diminutive grain size are relatively unimportant.

Textures are similar, as in mineral assemblage, for all three levels. Sphalerite appears to be the most abundant mineral and contains grains and blebs of all other sulfides. In sphalerite, galena occurs as irregular tiny grains, whereas sphalerite occurs as rounded grains in galena near boundaries of larger masses of the two sulfides. Pyrite and arsenopyrite usually are cube-shaped except where broken, but pyrrhotite occurs as rounded grains in sphalerite and occasionally as rounded grains in galena and pyrite. Chalcopyrite veinlets cut sphalerite, and irregular small masses of chalcopyrite occur in both galena and sphalerite. Interlocking is moderate to intense and varies with grain size. Larger masses of galena and sphalerite are interlocked only moderately along grain boundaries, but some areas of sphalerite contain relatively large quantities of galena and pyrrhotite. Most of the galena and pyrrhotite inclusions are about 0.05 mm. in diameter. Therefore, where the entire sulfide mass is very fine grained there is a considerable amount of other sulfides locked in the sphalerite. Galena is less affected by an abundance of inclusions.

Veins at the Montana Standard are transverse fissure fillings that cut quartzites and argillites of the Ravalli Formation. MacDonald (1906, p. 50) considers the rock as Burke Formation. A small southwest-trending fine-grained black diorite sill is evident in all three levels. In adit No. 3 the sill outcrops at the portal, and its eastern contact strikes about S. 10° W. Adit No. 2 contains a small block of diorite at the face in the southwest drift, and the same (?) diorite sill is exposed in adit No. 1, 850 feet from the portal and near the face of the southwest drift.

A large dike of medium-grained diorite is exposed for the first 200 feet from the portal of the lower adit. There is no mineralization in either of the two diorite bodies.

SHAMROCK

The Shamrock mine is in the N½ sec. 25, T. 21 N., R. 31 W. The abandoned and caved workings are on the ridge west of Shamrock gulch, a tributary gulch to Prospect Creek. The foundation of an ore bin or mill can be seen north of the road at the mouth of the gulch.

First mention of the mine is in Walsh and Orem (1906, p. 132). The mine was operated through a series of tunnels (adits) the longest of which was 1,000 feet. An east-west striking vein was reported to carry values in gold and silver. The Shamrock Gold Mining and Milling Co. was developing the property with a crew of 15 men.

The May 2, 1908 issue of the Mining World (v. 28, no. 18, p. 736) reported that the Shamrock Mining Co. had 11 claims that were developed by numerous "tunnels and upraises." "Tunnel no. 1 is in 285 feet; no. 2, 1,116 feet; and no. 3, 1,812 feet; all of them being connected with 3-compartment shafts." A 5-stamp mill had been erected to concentrate the gold-bearing sulfide ores. In 1908 a shipment of 300 tons of ore was recorded for the mine, from which 20 ounces gold, 176 ounces silver, and 165 pounds of lead were recovered.

In 1912 Walsh (1912, p. 102) reported that the mine was owned by the Florence Mine and Developing Co. The property was still being developed, and mill tests were being run. No further reference after 1912 could be found.

During the summer of 1961 all underground workings were caved. The dumps contained a few scattered pieces of iron-stained quartz, but

no sulfide minerals could be seen. An assay of selected dump quartz revealed a content of 0.04 ounce gold and 2.51 ounces silver.

Most of the dumps contain fragments of white to light-purple quartzite and argillaceous quartzite. The Geologic Map of Montana (1955) shows the area around Shamrock Creek to be underlain by the Ravalli Formation.

OTHER PROPERTIES

Excerpts from various publications are given below for prospects whose locations could not be determined. The reader will notice that many of the general descriptions of these properties places them very near to mines already described. It may be they are actually early names for the better known mines of today or they may be the names of claims incorporated in later and larger holdings. Known or not, they are presented here for the sake of completeness.

"The *Eagle Mountain* mine situated on Prospect Creek, 7 miles south of Thompson Falls, has been operated by a tunnel, cutting the country for a length of 1,000 feet to where the vein has been exposed, uncovering several well defined ore bodies carrying lead-silver values of a concentrating character. The formation of the country is quartzite. The property has been developed extensively under the supervision of H. McGilles" (Walsh and Orem, 1912, p. 105).

"It is reported that Spokane parties have acquired the *Eagle Mountain* and *Mint* mines, adjoining at Thompson Falls, and some important new development is being outlined. In the *Eagle Mountain* mine more than 2,000 feet of development have been done and considerable low-grade lead-zinc ore has been revealed in the upper tunnel. The lower tunnel is said to be within 75 feet of where it will top the downward extension of the ledge" (The Mining Journal, 1928, no. 11, p. 44).

Gilbert (1935, p. 69) lists the *Eagle Mountain Mining Co.* as follows:

Officer: W. H. Herrick, Wallace, Idaho

Property: 6 unpatented claims, Prospect Creek, 6 miles N (south) of Thompson Falls, Prospect Creek district.

Ore: Gold, silver, lead.

Development: 1,200-foot adit.

Remarks: Last operated in 1931.

Trauerman (1940, p. 98) lists the *Apex* as follows:

Operator: D. C. Ridlon, Wallace, Idaho.

Property: 5 unpatented claims and millsite, 10 miles from Thompson Falls on Prospect Creek. Low-grade ore.

Development: 500-foot tunnel on 400-foot level; 300-foot tunnel on 70-foot level.

Equipment: Partly equipped mill.

Remarks: Operated in 1939.

An owner's report to the W. P. A. Mineral Survey, Montana (about 1939-40) adds that concentrates were last shipped in 1912 and total production is unknown.

Walsh and Orem (1912, p. 104) describe the *Gilbert* property: "This property, situated 7 miles south of Thompson Falls, is owned by the Denver and Gilbert Mining Company, F. A. Gilbert, manager, and employes 7 men. The property has been developed by tunnels having a length of 800 feet, 300 feet having been accomplished during the year and uncovering some very high grade material carrying gold and silver. The work has been conducted in a safe manner as far as developed."

In 1906 MacDonald (p. 51) described the operations of the *Rosebud Mining Co.* "The *Rosebud Mining Company* is exploring several claims near the mouth of Rosebud Creek, a small tributary which enters Prospect Creek about 9 miles above its mouth. A vein of white quartz has been found by this company in the upper part of the Prichard Formation. One of the owners reported that it carries some silver chloride and over $100 per ton in gold in the weathered zone at the surface."

Rowe (1911, p. 1033) also commented on the prospect which he describes as the only mine of any importance (in the district) as far as gold is concerned.

The Mining World (1906, v. 25, no. 4, p. 107) describes the *Jim Fisk*: "George Thayer of the Pondera Smelting Company at Sand Point, who recently bonded the *Jim Fisk* mine on Prospect Creek from George Burson and others is working a large crew of men at the property and expects to make a good showing before the snow flies."

An interesting side-light on the building of the Thompson Falls hydro-electric plant is also presented in the above reference.

"Work on the proposed power plant at Thompson Falls is progressing slowly; a few men being engaged in cutting a tunnel through the mountain from the slough through which water will be conveyed to the power plant. At this point it is said a 60-foot fall can be obtained. A wing dam will be constructed between the falls and the slough to divert the water. At the present rate of progress, however, it is not likely that the plant will be installed before next year. There is an immense water power at Thompson which it is believed can be utilized in the operation of the mines and mills of the Coeur d'Alenes."

REVAIS CREEK DISTRICT

The Revais Creek district, or as it is sometimes called, the Dixon district, is predominantly in sec. 4, T. 17 N., R. 22 W., and sec. 33, T. 18 N., R. 22 W. A few prospects are in sec. 5, T. 17 N., R 22 W. The district is drained by the swift and youthful Revais Creek which flows through an

area of high relief. For most of its length this north-flowing tributary of the Flathead River traverses a narrow steep-walled canyon whose sides rise 1,000 to 5,000 feet above the canyon floor.

Between 1910 and 1949 production from the Revais Creek district has been fairly continuous. (See table 16.) During this span of time production was recorded for 29 years. Total ore produced was 9,099 tons from which 1,277 ounces gold, 5,752 ounces silver, 1,392,791 pounds copper, and 22 pounds lead were recovered. Total value of metals was $242,296 or an average value of $26.63 per ton. The platinum group metals at the Drake mine undoubtedly were recovered with the gold and payed for at the prevailing gold price.

Sahinen (1936, p. 4-7) has aptly described the general geology of the district as follows:

"The greater portion of the area south of Dixon is underlain by hard argillaceous rocks which have been mapped by Clapp* as belonging to the Ravalli group of the Belt series. The Belt series is of Proterozoic (Algonkian) age. These rocks consist of red to green argillites and argillaceous quartzites, and green-grey to light and dark grey argillite and sandy quartzite. At the Drake mine the country rock is a pure white sandy quartzite, in places, but the light color here may be due to the bleaching effects of the hydrothermal solutions which have acted upon the rocks. Near the headwaters of the Magpie Creek, in the western part of the mineralized area, the Ravalli group quartzites are in normal contact with the underlying, older Prichard formation, also of the Belt series. * * * The rocks are part of an extensive system of somewhat metamorphosed sediments over 50,000 feet thick which underlie the greater part of northwestern Montana and northern Idaho. They are the host-rocks of many important ore deposits in both northwestern Montana and northern Idaho. The Ravalli quartzites strike from about due north to N. 55° E. and dip from 30° to 80° E. or SE. They are folded and faulted. North of Dixon and Salish a fault drops the Ravalli Formation against the older underlying Prichard rocks.

"Along Revais Creek, the Ravalli formation has been intruded by a large sill-like mass of dark colored hornblende gabbro. The mass strikes about due north (parallel to the bedding of the intruded rock) at its southern end, but gradually

* Clapp, C. H., 1932 Geology of a portion of the Rocky Mountains of northwestern Montana: Mont. Bur. Mines and Geol. Memoir 4.

TABLE 16.—Production of gold, silver, copper, lead, and zinc in Revais Creek (Dixon) district, Sanders County, Mont., 1906-61, in terms of recoverable metals.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)	Value Total
1906-09	No production	—	—	—	—	—	—
1910	28	11	42	6,096	—	—	$ 1,016
1911	24	9	32	5,593	—	—	628
1912	26	12	32	5,149	—	—	698
1913	38	41	64	9,987	—	—	2,425
1914	No production	—	—	—	—	—	—
1915	58	8	93	15,056	—	—	2,833
1916	15	—	24	6,299	—	—	1,572
1917	19	—	48	8,278	—	—	2,300
1918	54	—	9	4,857	—	—	1,208
1919	28	6	22	5,597	—	—	1,180
1920	22	1	22	4,585	—	—	876
1921	No production	—	—	—	—	—	—
1922	22	3	26	4,511	—	—	703
1923-24	No production	—	—	—	—	—	—
1925	25	11	37	5,905	—	—	1,080
1926-30	No production	—	—	—	—	—	—
1931	88	39	67	12,534	—	—	1,962
1932	618	98	546	106,254	—	—	8,877
1933	50	6	43	9,859	—	—	768
1934	No production	—	—	—	—	—	—
1935	76	11	103	14,265	—	—	1,649
1936	134	15	71	26,837	22	—	3,050
1937	698	79	733	96,380	—	—	14,994
1938	62	7	48	4,694	—	—	736
1939	287	46	389	153,336	—	—	17,821
1940	592	150	682	225,319	—	—	31,196
1941	2,458	66	367	92,000	—	—	13,427
1942	800	12	83	4,300	—	—	999
1943	No production	—	—	—	—	—	—
1944	25	7	45	17,400	—	—	2,626
1945	412	74	225	74,600	—	—	12,821
1946	723	259	542	138,000	—	—	31,859
1947	908	192	715	183,300	—	—	45,860
1948	694	105	526	132,800	—	—	32,969
1949	115	9	116	19,000	—	—	4,163
1950-61	No production	—	—	—	—	—	—
Total	9,099	1,277	5,752	1,392,791	22	—	$242,296

swings off to the east, striking about N. 25° E. a mile or so south of the Drake mine. Due to the covering of talus or scree along the eastern slope of Revais Creek valley, its outcrop is not conspicuous, and its true width cannot be readily determined. However, on the Revais claim at the south end of sec. 33, T. 18 N., R. 22 W., the Brown tunnel which crosscuts the entire dike, shows it to be 335 feet in width. At the Drake mine, the dike has been crosscut for a distance of over 200 feet, and on the Lucky Strike claim for over 300 feet but the eastern edge was not reached by either development. It has been traced along its strike almost continuously for over 8,000 feet. A similar dike is exposed to the west of Revais Creek, but is not so well exposed. It is thought to be continuous from a point on Revais Creek about a mile south of the Drake mine to the headwater of Magpie Creek, a distance of over 22,000 feet; although it is said to be exposed at but four localities, the Blue Bell and Grey Horse, the Pine Top and Pine Cone, the Bay Horse (Coyote Bill), and the White Cloud claims, all four places being several thousand feet apart. This dike strikes about N. 55° W. cutting across the bedding of the inclosing rock.

"The gabbro is a comparatively soft greenish-grey medium and fine-grained rock composed of altered basic feldspars and hornblende. Where exposed in the tunnels, it sometimes appears to have a banded structure which may have been caused when intruded. Most of the gabbro, as found in the mines and prospects, is highly altered and greenish grey talc or serpentine is common. Locally, the gabbro shows disseminations of chalcopyrite and pyrite. Chalcopyrite is quite plentiful in some specimens from the Lucky Strike claim. The gabbro contains from a trace to about 0.10 ounce of the platinum group metals per ton, the average of 30 analyses being about 0.03 ounce per ton. At the present price (1936) of platinum, this rock would be worth about $1.00 per ton provided all the metal was platinum, however, two-thirds of the material reported as platinum group metals is usually palladium, and only one-third platinum."

DRAKE (GREEN MOUNTAIN)

The Drake mine is in N½ sec. 4, T. 17 N., R. 22 W., on the east slope of Revais Creek. Three unpatented, but surveyed, claims—the Trade Dollar, Dixon, and Eagle—comprise the property and are about 6½ miles southwest of the town of Dixon. (See pl. 4.) The mine is easily reached by way of the Revais Creek road which joins U. S. Highway 10-A about 3 miles west of Dixon.

Most of the following discussion has been taken from reports by Elstone (1955) and by Sahinen (1936).

In 1910 the Drake brothers discovered the mineralization at the site of the present mine. They located three claims and began to ship oxidized copper ore from shallow surface workings. Their production continued until 1931 when the mine was leased by the Dixon Mining and Milling Co. In addition to the three original claims, the company also leased the Lucky Strike claim. Shipments of ore continued under the management of the Dixon Mining and Milling Co. and other lessees until, in 1939, the Green Mountain Mining Co. bought out a leaseholder and assumed the operation of the mine. Elstone (1955) provides the following description of the Green Mountain's operations:

"The company sunk a shaft of 58 feet below the original main adit working level and began actual development and ore shipments from the No. 2 level. In 1941 a 50-ton mill was installed on the property and a camp was constructed. Production continued from this horizon but this ore was cut off on a fault. Driving along the fault failed to disclose the displaced segment and it was not found until the (U. S.) Bureau of Mines drilled 2 holes from the surface during the summer of 1943. In 1944 development and ore production resumed from the south side of the fault until it was interrupted in 1945 by fire which destroyed the mill, hoist house, and burned out timber in the shaft workings. A new mill was installed in 1946 and production was resumed. An inclined winze was sunk along the vein in the south end of the mine to open a No. 3 level. From this level the company mined considerable ore and ran a long drift into the neighboring Mayflower claim which was held under lease. The development proved unsuccessful, and having exhausted their finances, the Green Mountain Mining Company closed down in 1949. During the period of operation by the Green Mountain Mining Company they completed payment for the property out of the ore shipments and now own the property. * * * Shipment records of sorted crude ores shipped direct to the smelter varied from 5 to 35 percent copper, 1 to 4 ounces silver, 0.05 to 1.0 ounce gold and 0.05 to 0.5 ounce platinum. Shipments of mill concentrates observed averaged from 40.0 to 49.8 percent copper, 3 ounces silver, 0.5 ounce gold, and 0.5 ounce platinum.

"In 1950 the Kootenai Copper Mines, Inc., leased the property for a 50-year period and began rehabilitation in 1951. In 1953 and 1954 a winze was sunk 100 feet to open up the No. 4 level, but ran out of finances before any production could be started from that level. Two small shipments (were) made while sinking the winze * * * ."

In the July-August 1953 issue of the Montana Mining Association Newsletter it was reported that the Amador Mining Co. had entered into an agreement to purchase the long term lease of the Kootenai Mines, Inc., but no further mention is made of this company's activities. The property has been idle since 1954.

In the summer of 1961 the shafts were in such a state of disrepair that an examination of the underground workings could not be made. Consequently, the following description of the ore deposit is taken entirely from Sahinen (1936, p. 7-10).

"Ore deposits (in the district) containing platinum, gold, silver, and copper are associated with the gabbro intrusives along Revais Creek. (See pl. 4.) Although the gabbro itself contains small amounts of metallic minerals, as previously mentioned, the highest grade material, and that which has been commercially exploited, occurs along the contact of the gabbro with the enclosing quartzite. The best developed deposit of this type is found in the Drake mine, in sec. 4, T. 17 N., R. 22 W. The ore is found in a crushed and altered zone along the contact of the gabbro with dark-grey shaly quartzite and hard compact white quartzites. There seems to have been considerable movement along the contact, as much gouge or fault selvage has been developed along it. Some ore is also developed along faults entirely within the gabbro, and some white quartz veins are found along the faults in the gabbro. The ore zone varies greatly in width and character. In some places it consists of a heavy seam of fault clay with pockets of extremely rich dark-red oxidized material high in copper, silver, gold, platinum, and palladium. In other places, the ore is formed in relatively hard quartz veins 1 to 5 feet in width. This hard ore is not as high in metals as is the soft ore but appears to be more uniform in width, although not in quality. Although the crushed zone is over ten feet wide in places, the actual width of true vein matter seldom exceeds two feet, and is commonly much less.

"In the Drake mine, the zone in general strikes due north. The dip is extremely variable; at the north end it dips from 60° to 90° E. and at the south end, from 45° to 90° W. In places the "vein" is very flat, giving the impression of a much greater width. In general, the "vein" consists of a crushed zone, mainly of crushed and serpentinized gabbro, with lenses of hard white sugary quartz stained by oxidized copper minerals, and indefinite streaks of clay containing copper and iron oxides. Platinum, as well as gold, silver, and copper, were found in all of the material assayed.

"The medium-grained hornblende gabbro at the end of the south crosscut, although relatively fresh as compared to the gabbro next to the "vein", shows blotches of chalcopyrite partly altered to copper-pitch or tenorite. An assay of the freshest specimen of rock showed 0.0125 oz. gold, 0.180 oz. silver, and 0.0025 oz. platinum per ton, no palladium. The percentage of sulphides in this rock is very low, less than 1 percent.

"A quartz vein, cutting the gabbro in this crosscut, shows the presence of precious metals. This vein does not contain the copper minerals characteristic of the veins along the contact. An assay showed 0.01 oz. in gold and 0.12 oz. in silver, per ton.

"The highest grade ore is found in the fault zone at the contact of the whitish quartzite with gabbro. It is a red oxide ore consisting almost entirely of iron oxide (hematite) with considerable copper oxide and a small amount of clay. An assay on picked material from the west drift showed the following: Gold, 0.210 oz; silver, 1.50 oz.; platinum, 0.61 oz.; palladium, 1.00 oz.; and copper, 11.88 percent. This is much higher in grade than any of the hard quartz ore assayed. The highest grade "hard ore" showed: 0.130 oz. gold; 2.250 oz. silver; 0.30 oz. platinum; 0.40 oz. palladium; and 11.28 percent copper. Another high-grade sample showed more gold and silver, but less platinum, palladium, and copper. It ran: 0.210 oz. gold; 0.300 oz. silver; 0.05 oz. platinum; 0.15 oz. palladium; and 4.56 percent copper. This material consists of white quartz with the oxidized copper minerals, chrysocolla and malachite and some limonite, pseudomorphic after cubic pyrite.

"All of the ore encountered in the present workings is completely oxidized, and no sulphide minerals were observed in the fresher gabbro itself, but even these are, for the most part, altered to limonite and copper-pitch or tenorite which occur as halos around a core of chalcopyrite. Copper minerals in the veins have been leached, and probably much of the copper content has been carried downward to a zone of secondary enrichment. The zone in which the secondary sulphide precipitation should take place has not been reached by development in any of the prospects in this area. In the Drake mine, a winze from the main tunnel level has been sunk to a depth of 400 feet along the vein, but the ore is still completely oxidized (?). Owing to this leaching and migration of the copperbearing solutions, the copper content of the veins are extremely variable from place to place, and range from a fraction of one percent to over twenty percent. The content of precious metals does not vary so greatly, but even these are sometimes rather erratic in distribution. In the ore shipped, the ranges in precious metal content was gold, trace to 1.5 oz.; silver, 0.6 to 2.5 oz.; and platinum, trace to 0.502 oz. In some picked specimens, platinum reaches 0.61 oz. and palladium 1.00 oz. per ton. The average ratio of platinum to palladium is 1 to 2, or ⅓ of the platinum group metals is present as platinum and ⅔ as palladium. The approximate average metal content per ton of the ore shipped is: copper, 13 percent; silver, 1.3 oz.; gold, 0.36 oz.; and platinum, 0.25 oz. Of this, the palladium content should be 0.5 oz./ton. The gross value of this mythical ore at the present market prices (1936) for all five metals including palladium is approximately $40.00 per ton provided *all* metals were paid for. However, the net value would be somewhat

TABLE 17.—Production of gold, silver, copper, lead, and zinc, 1910-61, for Drake group (Dixon, Eagle, Trade Dollar, Mayflower, Lucky Strike), Revais Creek district, Sanders County, Mont., in terms of recoverable metals.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
1910	28	11	42	6,096	—	—
1911	24	9	32	5,593	—	—
1912	26	12	32	5,149	—	—
1913	38	41	64	9,987	—	—
1915	58	8	93	15,056	—	—
1916	15	—	24	6,299	—	—
1917	19	—	48	8,278	—	—
1918	16	—	9	3,568	—	—
1919	28	6	22	5,597	—	—
1920	22	1	22	4,585	—	—
1922	22	3	26	4,511	—	—
1925	25	11	37	5,905	—	—
1931	88	39	67	12,534	—	—
1932	618	98	546	106,254	—	—
1933	50	6	43	9,859	—	—
1935	76	11	103	14,265	—	—
1936	134	15	71	26,837	22	—
1937	659	78	720	94,450	—	—
1938	42	3	29	2,891	—	—
1939	287	46	389	153,336	—	—
1940	592	150	682	225,319	—	—
1941	2,458	66	367	92,000	—	—
1942	800	12	83	4,300	—	—
1944	25	7	45	17,400	—	—
1945	412	74	225	74,600	—	—
1946	676	245	480	125,949	—	—
1947	908	192	715	183,300	—	—
1948	694	105	526	132,800	—	—
1949	115	9	116	19,000	—	—
1950-61	(no production)					
Total	8,955	1,258	5,658	1,375,718	22	—

lower. However, there is much material which does not reach this grade, but which could be profitably worked in a local mill, provided that sufficient tonnage to warrant the construction of such a mill were developed. The possibilities of developing a sufficiently large tonnage of the lower grade material appears to be favorable, at least locally, if not throughout the extent of the north-south dike."

Production of the Drake group is shown in table 17.

OTHER PROPERTIES

Although the Drake mine is the most important mineral producer in the Revais Creek district, numerous prospect adits have been driven along the gabbro intrusive. Some have shipped small lots of ore.

The *Blue Ox* has a recorded production in 1937 of 39 tons of ore containing gold, silver, and copper. No stopes were observed in the *Blue Ox* adit, but there may have been such a stope along the caved crosscut that follows a heavy fault 265 feet from the portal. Production might also have come from surface pits. Geologically the *Blue Ox* adit is important because the underground workings crosscut the gabbro sill. (See pl. 4A.) A steeply dipping contact between fine-grained, light-grey (bleached ?) quartzite and fine-grained black gabbro strikes N. 45° E. and dips 62° SE. The sill is 340 feet wide in the adit and its eastern contact strikes N. 8° E. and is vertical. The contacts are not well defined. In places the gabbro appears to crosscut bedding; at others it appears to be conformable to the bedding. Some magmatic stoping probably took place during the intrusion. Wall rocks apparently have been bleached for distances of 2 to 6 feet from the contact.

The *Lucky Strike* has a recorded production, in 1946, of 47 tons of ore which yielded 14 ounces gold, 62 ounces silver, and 12,051 pounds copper. No stopes were observed in the underground workings of three accessible adits. The ore was probably mined from surface. The west contact between gabbro and light-colored quartzite is exposed in two adits. Both contacts in the adits below the open cut are angular contacts.

Five small quartz veins in gabbro are exposed in the open cut on the *Lucky Strike*. The veins range from one-half to 20 inches in width, and all strike about N. 10° to 15° W. and dip about 19° NE.

Analyses of 3 channel samples and 1 selected sample are shown in table 18.

The *Slow Poke* adit crosscuts the west contact, which here is a northwest-trending fault that dips 34° SW. The adit has also intersected a green copper-stained northeast fault, dipping 20° to 38° SE. that contains a few scattered lenses of vein quartz.

TABLE 18.—Analyses of samples, Lucky Strike claim.

Sample No.	Gold (oz.)	Silver (oz.)	Platinum Group	Copper (%)
SNC-86[1]	0.190	0.20	none	0.14
SNC-87[2]	0.003	0.10	none	0.82
SNC-88[3]	0.001	none	none	0.11
SNC-90[4]	0.020	1.70	none	11.55

1—SNC-86 20-inch channel sample of uppermost quartz vein at east face of pit.
2—SNC-87 channel sample across 4-inch vein about 10 feet below SNC-86.
3—SNC-88 3-inch channel sample from vein about 1 foot below SNC-87.
4—SNC-90 selected sample from high-grade ore pile.

A short adit on the *Mayflower* claim that was started in the gabbro and was driven across the eastern contact was about 50 feet long in 1936 (Sahinen, 1936, p. 14). This adit intersects the eastern contact between quartzite and gabbro at a small angle to the bedding of the quartzite. The contact is said to be free from fault gouge.

A 65-foot adit and a 50-foot shaft have been driven on the *Blue Bell* claim, which is slightly west of the *Mayflower*. The adit has been driven on the northwest-trending gabbro, but mineralization is sparse (Sahinen, 1936, p. 14).

Two adits, 10 and 20 feet in length have been driven on the *Pine Cone* claim, 9,000 feet northwest of the *Blue Bell*. Both show slight mineralization in gabbro.

Small amounts of platinum have been reported from workings on the *Bay Horse* (*Coyote Bill*) and *White Cloud* claims, which are 6,500 and 12,500 feet, respectively, northwest of the *Pine Cone*. All underground workings on both claims are in gabbro of the northwest-trending intrusive.

SEEPAY CREEK DISTRICT

The Seepay Creek district encompasses the drainage of Seepay Creek, a north-flowing tributary of the Flathead River. The creek enters the river about 2½ miles west of Perma.

Thin-bedded grey to black argillites of the Prichard Formation with some beds of quartzite underlie the entire drainage except for a small area of Ravalli Formation near the southern tip of the district. The northern portion of the district is cut by massive gabbro sills. (See pl. 1B.) One sill, not previously shown on the Geologic Map of Montana, in sec. 19, T. 18 N., R. 23 W., at the New Deal mine, contains copper mineralization. A small quartz vein in gabbro, believed to be on a continuation of this same sill near Seepay Creek in NE¼ sec. 26, T. 18 N., R. 24 W., is unmineralized.

The only other prospect visited within the Seepay Creek drainage is the pyrrhotite-bearing quartz vein at the Lucky Lode.

The only productive property is the New Deal mine, which produced 1 small lot of copper ore in 1938.

LUCKY LODE

The Lucky Lode prospect is high on the ridge that divides Sanders and Missoula Counties. It is in the NW¼ sec. 6, T. 17 N., R. 23 W., about 1 mile northwest of Three Lake Peak and about 1 mile north of the county line. The prospect, which is at an elevation of 5,600 feet above sea level, is reached by 5¼ miles of poor road and jeep trail up Seepay Creek and then by foot or pack trail about 1 mile up the east and middle forks of Seepay Creek.

Two adits and several prospect pits have been opened along a massive east-west striking quartz vein that parallels bedding planes and contains small amounts of galena, pyrite, chalcopyrite, pyrrhotite, and pentlandite. (See pl. 5A.)

The bedding-plane vein strikes slightly north of east on the surface but strikes about N. 75° W. underground in both adits. The dip ranges from 55° to 70° SW. and width averages about 6 feet. Thin- to medium-thick bedded argillites are the predominant wall rock, but a few beds of black quartzite are present. According to the Geologic Map of Montana (1955) the Prichard Formation underlies the area, and the lower Ravalli Formation is found overlying Prichard about half a mile south of the prospect.

Although the vein appears to be a filling between bedding planes, some irregular offshooting veinlets on the hanging wall side replace, in part, the argillites. Mineralization is erratic throughout massive quartz and consists of pods of sulfides up to 4 or 5 inches across, scattered sparsely throughout the vein.

Pyrrhotite, the most abundant sulfide, occurs as masses and as scattered grains and most specimens contain tiny grains of chalcopyrite, which occur with and replace pentlandite. Chalcopyrite veins replace the pentlandite along serrate edges. As determined by chemical tests, the nickel content is low, but is present throughout pyrrhotite-rich areas, probably as pentlandite in solid solution with pyrrhotite. A chemical analysis of a muck-pile sample contained 0.14 percent copper, and no gold, silver, platinum group, cobalt, or nickel.

NEW DEAL (TEDDY BEAR)

The New Deal mine is about 7 miles south of U. S. Highway 10-A along the Vandenberg Lookout road, which leaves the highway 2½ miles east of Perma. Surface and underground workings are in NW¼ sec. 19, T. 18 N., R. 23 W., at about 5,200 feet above sea level. The mine, listed as the Teddy mine, is shown on the preliminary Perma quadrangle topographic map (U. S. Geological Survey).

Early history of the mine is not known, but an article in the Mining Journal (1934, v. 18, no. 13, p. 19, and 1938, v. 22, no. 1, p. 26) states that a crosscut adit, part of which is shown on plate

5B, was started in 1934. Prior to this time work had been done on shafts and surface pits. In 1938, five unpatented claims comprised the property and according to production records 18 tons of ore were shipped containing copper. The mine is presently owned by Elmer Allen of Dixon, Montana.

Surface development consists of numerous old cuts, most of which have been partly filled with dirt, and an inaccessible vertical shaft, said to be 100 feet deep. (See pl. 5B.) A 430-foot adit, about 150 feet below the surface workings, is open for most of its length except for an unknown distance past the caved end of the southeast drift. (See pl. 5C.)

Mineralization is in transverse veins in a northeast-trending gabbro sill. The veins could not be seen on the surface, but a line through the surface cuts strikes N. 22° W. The continuation of this strike is also confirmed by geochemical anomalies.

The large unmineralized quartz vein shown in plate 5C is faulted and broken at this point, but as near as could be determined its strike is N. 30° to 35° W. and the dip is 53° NE. A dip to the northeast would cause the outcrop to be downhill from the line of surface workings. However, in the southeast drift the projected splits of the vein are vertical or dip steeply southwest.

Actually, the quartz vein exposed underground may not be the same as that worked near the surface. Dumps at surface are covered with chalcedonic quartz, which contains malachite, tenorite, and chrysocolla. Underground the vein is massive milky quartz with no visible mineralization.

Soil samples were collected during the late summer of 1961. Three sampling traverses were run downhill across the projected line through the surface workings. Traverses and graphed results are shown on plate 5B. As one can observe, the anomalies are hardly more than a single high sample. However, on ND-1 and ND-3 the anomalies do coincide with the projected "vein." Traverse ND-2 does not reveal a high at its downhill end, but this may be due to the failures to extend the traverse a sufficient distance downhill. The anomaly at sample 1 and 2 of ND-2 is probably due to the proximity of the haulage road. Too much credence should not be placed on results of these soil samples as a single-sample anomaly cannot be considered reliable.

The samples were taken to see if soil sampling would be effective over gabbroic rocks in heavy soil cover and to attempt to locate a hidden vein. The low results could be explained by assuming that the heavy soil cover is masking the metal content or that areas underlain by gabbroic rocks or the detritus therefrom is not the best place to carry out soil sampling programs. However, results in other nearby areas prove this is not the case. It is the writer's opinion that the amount of mineralization is reflected in the sampling results. Perhaps additional soil sampling traverses would reveal the locations of higher-grade ore pockets along the structure.

THOMPSON RIVER DISTRICT

Thompson River encloses the largest single tributary drainage system in Sanders County, and although the number of mines present is limited, it is one of the largest mining districts. For the purpose of this report the mining district will encompass the entire drainage system of the river.

Flowing from north to south the Thompson River transects a series of folded Beltian sediments composed predominantly of Ravalli and Wallace Formations. For the northern two-thirds of its length the river flows through a broad area of Quaternary alluvium composed of reworked glacial moraines, normal stream gravels, and glacial clays. It can be inferred, however, that the axis of a broad syncline is buried beneath this unconsolidated material. (See pl. 1B.) The southern end of the river near its junction with the Clark Fork River cuts diagonally across a major anticline which exposes a core of Ravalli Formation rock and flanks of overlying Wallace Formation farther upstream.

One might call the district the silver-copper-lead district of the County, for all the mines produced the three metals. The most prominent mines are grouped in a small area on both sides of the river about 3½ miles north of U. S. Highway 10-A.

During 1961 the Raven mine was being actively worked and a caved portal of the Copper King had been reopened.

This small productive area, within a very large nonproductive area, has had a long period of activity. In the early 1880's a number of mines in this area were being developed, and several were producing small lots of rich ore. The Belle Stowe (Silver King), Buckeye, Ohio, Climax, Pay-Master, and Treasury are all named in early-day accounts. However, all but the Belle Stowe have lost their present-day identity through unrecorded name changes or consolidation with other properties.

Total production for the district from 1906 to 1958 has been 943 tons of ore, from which 3 ounces gold, 27,118 ounces silver, 143,535 pounds copper, 115,602 pounds lead, and 5,700 pounds zinc have been recovered. (See table 19.) Total value of the metals recovered is $52,722 or an average value of $55.91 per ton. Average grade for all ore is 28.76 ounces of silver per ton, 7.6 percent copper, 6.1 percent lead, and for 293 tons of zinc ore (only tonnage credited) the average grade was 0.97 percent zinc.

The over-all character of the ore deposits matches closely the somewhat hidden facts of the production records. Small shipments of rela-

TABLE 19.—Production of gold, silver, copper, lead, and zinc in Thompson River district, Sanders County, Mont., 1906-61, in terms of recoverable metals.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)	Total Value
1906-12	No production	—	—	—	—	—	—
1913	14	—	507	4,708	—	—	$ 1,038
1914-15	No production	—	—	—	—	—	—
1916	72	—	2,311	20,907	4,637	—	6,984
1917	116	—	4,473	16,100	15,594	—	4,724
1918	65	—	2,234	1,997	7,448	—	2,349
1919	31	—	1,153	9,908	—	—	3,143
1920	26	—	845	8,977	—	—	2,579
1921	15	—	734	375	2,337	—	887
1922	16	—	1,437	3,887	306	—	1,981
1923	53	1	1,653	17,622	163	—	3,972
1924	33	—	1,153	834	26,554	—	3,006
1925	62	—	2,901	16,055	19,553	—	6,002
1926	54	—	941	7,379	6,006	—	2,110
1927	No production	—	—	—	—	—	—
1928	37	—	976	954	14,504	—	1,549
1929	No production	—	—	—	—	—	—
1930	1	—	324	—	—	—	125
1931	28	1	1,805	10,549	—	—	1,507
1932-33	No production	—	—	—	—	—	—
1934	23	—	1,519	6,825	—	—	1,528
1935-46	No production	—	—	—	—	—	—
1947	4	—	14	158	—	—	58
1948	150	1	1,159	15,000	5,000	400	5,287
1949	135	—	811	1,000	10,900	4,300	3,186
1950	8	—	168	300	2,600	1,000	707
1951-61	No production	—	—	—	—	—	—
Total	943	3	27,118	143,535	115,602	5,700	$52,722

tively high-grade silver-copper-lead ore coincide with what one might expect from narrow veins containing an assemblage of argentian tetrahedrite, chalcopyrite, enargite, galena, and secondary copper minerals.

In the Silver King, Copper King, and Raven mines one controlling factor to ore deposition seems to stand out. Mineralization along relatively strong steeply-dipping faults is most intense in brittle quartzite and slightly argillaceous quartzite. Exploration adits at the Silver King and Raven mines in sedimentary members of the Ravalli Formation are highly argillaceous and did not show mineralization. Thus it seems advisable that future exploration be confined to quartzitic layers along strong steeply-dipping faults.

COPPER KING (MASCOT)

The Copper King mine is in SE¼ sec. 33, T. 22 N., R. 28 W., on the west slope of Thompson River. (See pl. 6A.) The mine is easily reached by way of the Thompson River road and is about 3½ miles north of U. S. Highway 10-A. Two patented claims, the Copper King and Mascot, comprise the property which is owned by the George Wurm Estate, c/o C. G. Johnson, Trustee, Plains, Montana. Former owners (years unknown) were S. A. Hurlburt and Columbia Power and Electric Co.

Discovery of the vein at the Copper King must have been in the 1880's because Swallow and others (1890, p. 64) report that a group of copper mines across the river from the Silver King were employing 30 men and shipping copper ore to Butte. In 1909 after an apparent shut-down the mine was being reopened and unwatered, and a mill was being overhauled (The Mining World, 1909, v. 31, no. 9, p. 479). The mine was closed again until 1911 at which time it was reported that lessees were working the mine. In 1912 the controlling company, Thompson Falls Copper Mining and Milling Co., reopened the mine. A small shipment of copper-silver ore was made in 1913, and then production ceased until 1916. After 1919, for a period of about 8 years, the mine continued to produce on a small scale. In 1948 the largest tonnage of any year was shipped by F. R. Walkley from the Mascot claim. Total combined production for the Copper King and the Mascot mines after 1913 is shown in table 20.

TABLE 20.—Combined production of gold, silver, and copper, Copper King and Mascot mines.

Year	Ore (tons)	Gold (oz.)	Silver[1] (oz.)	Copper[2] (lb.)
1913	14	—	507	4,708
1916	41	—	914	20,165
1917	24	—	624	12,357
1919	19	—	232	4,384
1920	17	—	205	4,634
1922	10	—	210	3,460
1923	35	1	795	13,892
1925	24	—	651	11,539
1926	41	—	420	6,793
1947	4	—	14	158
1948	139	1	1,075	15,000
Total	368	2	5,647	97,094

1—Average grade, 15.3 ounces per ton.
2—Average grade, 13.2 percent.

TABLE 21.—Analyses of samples, Copper King mine.

Sample No.	Width	Gold (oz.)	Silver (oz.)	Copper (%)	Lead (%)	Zinc (%)	Antimony (%)	Bismuth (%)
SNC-41	5″	0.0025	14.10	16.70	0.4	0.5	0.60	0.15
SNC-42	8″	Tr	0.15	0.05	0.4	0.3	0.03	0.13
SNC-48	8″	0.0010	11.70	0.62	0.4	0.4	1.18	0.06

Development is by two adit levels, vertically about 130 feet apart, and an intermediate level 60 feet below the upper adit. The lower adit is at an elevation of about 2,500 feet above sea level. The intermediate and upper adit are connected by a winze along the vein. The vein has been stoped for an undetermined distance above and below the sill in both the upper and lower adits. There is a small stope, 10 to 20 feet high on the intermediate level. A two compartment winze in the lower adit is water filled. Adjacent to the winze and on the north side of the drift are the remains of a fairly large hoisting station. (See pl. 6B.)

Metallization in the form of fracture filling is along a N. 76° W. trending vein that cuts across the bedding of medium-grey to light-grey argillaceous quartzite and relatively pure white quartzite of the Ravalli Formation. The vein dips 55° to 72° SE.

Rarely are the veins wider than 2 feet and along most of their length the observable width is generally 6 inches. However, in the upper adit the average width must have been greater than 6 inches, for in the stoped area vein widths of 2 plus feet could be seen at the back.

Mineralization is most intense in the upper adit, less so in the intermediate, and in the lower adit the most mineralized part of the vein is that closest to the portal. The far ends of both intermediate and lower adits are only slightly mineralized. This suggests that the ore shoot, which is at its greatest observable width in the upper adit, rakes to the southeast and also suggests that part of the shoot has been eroded away.

A small amount of bleaching of wall rocks was observed in the lower adit near the largest underhand stope, but the bleaching extended only a few inches from the vein and might have been caused by ground water. Other alteration of wall rock was not observed.

Minerals at the Copper King are predominantly copper. Argentian tetahedrite is most abundant, followed by chalcopyrite, then bornite. Pyrite is present in minor amounts and enargite is rare. Malachite, chrysocolla, tenorite, and secondary covellite occur as veinlets in other sulfides. Olivene, which is also rare, occurs as scattered grains near the quartzite wall rock.

Table 21 shows analyses of three samples from the Copper King mine.

RAVEN (COPPER MASK)

The Raven mine is in SW¼ sec. 33, T. 22 N., R. 28 W., and NW¼ sec. 4, T. 21 N., R. 28 W., on the northwest slope of the Thompson River canyon about 3¼ miles north of U. S. Highway 10-A. (See pl. 6A.) A mill and lower adit are several hundred yards northwest of the Thompson River road, and the main working adit is high on the slope accessible by 4-wheel drive vehicles. The lower adit is at an elevation of about 2,700 feet above sea level, and the working adit is 400 feet above.

Although this mine was probably worked in the 1880's, its name at that time is not known. However, since 1919 its production is recorded under the name of Copper Mask. When the present owners took over the property they changed the name to the Raven.

In 1931 the Copper Mask Mining Co. was operating the mine. A net return of $31.22 per ton on a carload of ore was received from the Washoe reduction works at Anaconda. "The ore assayed 19.81 percent copper, 64.4 ounces of silver and 0.04 ounces of gold per ton" (The Mining Journal, 1931, v. 15, no. 3, p. 41). Similar listings appeared in various mining magazines until 1949 even though the last recorded production prior to 1958 was in 1934.

Gilbert (1935, p. 69) listed the Copper Mask Mining Co. as follows:

Officers: John Hickey, Pres.; John D. Kennedy, Vice Pres.; J. C. Harrah, Sec.-Treas., c/o Moorlight Mining Co., Philipsburg, Montana.
Property: 9 unpatented claims, 9 miles east of Thompson Falls, Thompson River district.
Ore: Silver, copper.
Development: 2,000 feet of drifts, 200 feet of raises.
Men employed: 3.

The present owners, the Raven Mining Co., have been operating the mine since 1959 and have made shipments of ore during 1959, 1960, and 1961. During 1961 the company was erecting a concentrating mill equipped with crushers and jigs.

TABLE 22.—Production of gold, silver, and copper, Copper Mask (Raven) mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)
1919	12	—	921	5,524
1920	9	—	640	4,343
1923	8	—	524	3,730
1925	5	—	286	2,202
1931	28	1	1,805	10,549
1934	23	—	1,519	6,825
Total[1]	85	1	5,695[1]	33,173

1—Average grade: 67.0 ounces silver per ton; 19.51 percent copper.

Production figures (not complete) are shown in table 22.

All four adits at the Raven are accessible except for a portion of the north crosscut in the lower adit, which is caved. The owner reports a raise along the fault at the caved end of the crosscut. The four adits, from bottom to top, are 600, 290, 470, and 150 feet long. There are several small stopes in each of the upper three adits. Surface facilities consist of mine roads to lower and main adit, a small concentrating mill, and a storage shed.

A narrow fissure vein in the upper three adits strikes N. 60° to 68° W. and dips 54° to 80° SW. The vein, which ranges in width from a few inches to about 28 inches, cuts white to light-grey quartzite with some interbedded grey argillites of the Ravalli Formation. Bedding of the wall rock strikes northwest and dips at low angles to the northeast.

Mineralization is irregular. Some portions of the veins are highly mineralized, such as the 10-inch wide lens near the winze in the main adit. Here the full 10 inches is solid argentian tetrahedrite, a channel sample of which contained 199.2 ounces of silver per ton, 31.8 percent copper, 0.5 percent lead, and 6.2 percent zinc along with 6.87 percent antimony and 0.20 percent bismuth. Other samples contain lesser amounts of these metals, and some portions of the vein appear to be barren of sulfides. However, the greater part of the vein contains some sulfide minerals which usually occur as masses of sulfides and rarely as scattered small grains.

From the opposite side of the river one can see what appears to be a number of closely spaced parallel faults, one of which is the Raven vein. However, the mapping of underground workings did not reveal such a system. It may be that any fractures parallel to the main fault are very minor and die out along their strike and probably along their dip in the fine-grained dense argillites.

Plate 6C shows cross sections through the four adits illustrating the projection of beds from a measured section (XX' on pl. 6A) south of the adits. It can be seen that mineralization is most intense in the predominantly quartzitic upper strata and that as far as can be determined mineralization is lacking in the thin-bedded argillaceous sediments below. This type of mineral occurrence reminds one of the Coeur d'Alene district where the most productive ore deposits occur in the quartzitic members of the Burke and Revett Formations. Argillaceous sediments have not proved to be notably rich ore-bearing formations in that much-studied mining district.

Minerals observed in ores from the Raven are pyrite, chalcopyrite, argentian tetrahedrite, bornite, covellite, chrysocolla, malachite, tenorite, azurite, secondary chalcocite, limonite, wittichenite (?), galena and enargite.

Tetahedrite is rimmed and veined by secondary chalcocite and covellite. Small grains of bornite, chalcopyrite, pyrite, galena, enargite, and wittichenite (?) are included in the larger irregularly shaped tetrahedrite grains. Many doubly terminated quartz crystals are also included in the tetrahedrite (fig. 14).

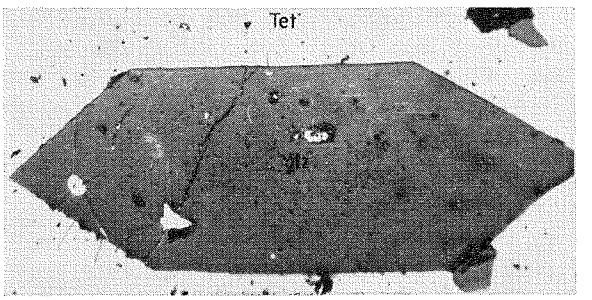

FIGURE 14.—Photomicrograph of ore from Raven mine, Thompson River district (Tet—tetrahedrite; qtz—quartz) (60x).

Tetrahedrite, bornite, chalcopyrite, and pyrite are the most abundant sulfide minerals. Wittichenite (?), enargite, and galena are very sparsely distributed through the ore.

The analytical results of samples taken from the Raven mine are shown in table 23. Sample numbers correspond with locations shown on pl. 6C.

FISHTRAP CREEK SANDSTONE QUARRIES

A quarry in Paleozoic sandstone, known as the McDonald quarry has been opened just south of the confluence of Fishtrap Creek and its West Fork. The rock is a banded greyish-red and white quartizitic sandstone. At the quarry the stone is split into blocks of roughly 4″ x 4″ cross-section for use as a building stone. Another quarry has been opened in the same bed about 3 or 4 miles northwest by the Sesco Corporation.

SALES

The Sales prospect embraces 5 patented claims on the ridge between the headwaters of Indian Creek to the east and the east fork of Whitney Creek to the west. The claims cover parts of sec. 1, T. 25 N., R. 28 W.; sec. 6, T. 25 N.,

TABLE 23.—Analyses of samples, Raven mine.

Sample No.	Width	Gold (oz.)	Silver (oz.)	Copper (%)	Lead (%)	Zinc (%)	Antimony (%)	Bismuth (%)
SNC-43	10″	0.0400	13.91	2.19	0.3	0.4	0.74	0.10
SNC-45	30″	0.0005	46.15	7.60	0.4	1.0	1.92	0.16
SNC-46	10″	0.0010	199.20	31.80	0.5	6.2	6.87	0.02
SNC-47	12″	0.0013	43.00	12.70	0.4	1.3	3.24	0.20

R. 27 W.; and sec. 36, T. 26 N., R. 28 W., and are owned by Ruth and Gordon Sales of Kalispell, Montana. The property is accessible by way of the Thompson River road to the Bend Ranger Station and then along the Whitney Creek road. Elevation at the base of the ridge is about 4,200 feet above sea level.

The Mining Journal (1920, v. 14, no. 1, p. 48) noted the Sales Mining Corp. had been organized to work the Wild Horse, Coming Day, Early Day, and White Pigeon patented claims. About 600 feet of tunnel had been driven on the property at that time, and assays were reported to run $25.38 to $96 per ton in silver and copper.

Underground workings were not accessible during the summer of 1961, but apparently there were two adits on the property, one near creek level and the other 150 feet above. Bulldozer cuts are very abundant along the west slope of the ridge. Surface facilities include the remains of a copper-precipitating plant. Apparently the plan of recovery was to leach the copper from the ore with a sulfuric acid solution and then precipitate the copper with metal shavings.

At the portal of the caved upper adit there is a zone of nearly parallel veinlets which strikes N. 36° W. and dips at a low angle to the northeast. The zone at this point is about 4 feet wide. The veinlets, averaging about a quarter of an inch in width, cut fine-grained whitish quartzites that strike N. 21° W. and dip 88° SW. Although this is the only locality where the mineralized zone was visible, pieces of copper-stained argillite are scattered through bulldozer pits and dumps for about 100 to 150 feet farther up the side of the ridge.

Except for a few outcrops of light-colored quartzite, most of the ridge is made up of medium-grey thin-bedded argillite that weathers light brown to tan and displays mud cracks and ripple marks. The Northern Pacific Railway Co.'s photogeologic interpretation map classifies bedrock in this area as belonging to the Striped Peak Formation.

Several faults cut the Striped Peak Formation in this area. A northwest-trending fault cuts Striped Peak at the prospect, but is offset to the west by a northeast-trending fault slightly south of the prospect. It may be that mineralization has followed the northwest offset and thus, future prospecting should be carried out southwest of present mineral exposures rather than to the east.

The top of the ridge is capped with patches of coarse gravel. Many of the round water-worn boulders in the gravel are striated which attests to their former glacial association. Alden (1953, pl. 1) depicts this area as one of the northernmost limits of the water of Glacial Lake Missoula, and shows the southern limit of the Cordilleran ice sheet a scant mile to the north.

The Northern Pacific's photogeologic interpretation map shows the W½ and NE¼ sec. 1, T. 25 N., R. 28 W., and the S½ sec. 36, T. 26 N., R. 28 W., as being covered with glacial deposits consisting of terrace gravel, sand, moraines, and fluvial and lacustrine deposits.

Consequently, the striated boulders are, most likely, part of a glacial moraine that was reworked by the glacial lake and later eroded until only a few remnants remain on the higher ridges.

Chalcopyrite is the only sulfide mineral noted at the Sales prospect. Most abundant are the secondary copper minerals, tenorite, chalcocite, malachite, cuprite, covellite, and chrysocolla in limonite.

SILVER KING (BELLE STOWE)

The Silver King mine is in NW¼ sec. 3, T. 21 N., R. 28 W., on the southeast side of the Thompson River about 3½ miles north of U. S. Highway 10-A. (See pl. 6A.) It is accessible by following a private logging road along the southeast side of the river to Buckeye gulch, then up Buckeye gulch a few hundred yards to the end of the road. The three adits are south of the gulch road.

Swallow and others (1890, p. 64, 70) first mentioned this mine, then known as the Belle Stowe. At that time the mine was the most productive in the district and employed a large force of men. Shipments were reported to be rich in silver, copper, and lead and yielded $900 to $1,000 per carload. Nickel and cobalt were said to be present. Swallow continued with the following description:

"The present development consists principally of two tunnels perpendicularly, one hundred feet apart, the lower one, 180 feet long. The upper tunnel has been driven on the ledge three hundred fifty feet and has encountered five distinct ore chutes, each of which shows in the level a distance of from thirty to forty feet. The ore is mostly copper glance, running well in silver. There is a small amount of nickel and cobalt, though not in sufficient quantities to justify extraction.

"This mine has shipped during the year an average of about twenty tons of ore per week. * * * The mine is in good condition and substantial shape. Thirty men are employed."

In 1920, the Mines Handbook (p. 952) reported that the Silver King Mining Co. was developing the property which was "said to have produced $100,000 up to 1919." The same company had 16 claims in the district according to the Mines Handbook (1926, p. 1109). A 12-inch thick vein assayed 54 percent lead, and 4 ounces of silver per ton. Development at that time was by shafts and tunnels, one of which was 1,800 feet long and which cut the vein at a depth of 700 feet.

By 1928 the mine was being developed by the Silver King Leasing Co., an unincorporated company which, it is reported, was leasing the mine

from A. L. Anderson. Preparations were being made to drive a "lower tunnel" (The Mining Journal, 1928, v. 12, no. 2, p. 45). Samples containing 23.5 percent lead and 60 ounces of silver per ton and test shipments which brought returns of $70.60 per ton were reported in the Mining Truth (1928, v. 12, no. 6, p. 26).

During August 1928, the Lloyd Mining Co. was organized to operate the mine (Mining Truth, 1928, v. 13, no. 12, p. 6). The lowermost tunnel was started by this company in hopes of intersecting the vein at depth. In 1929, the Mining Journal (v. 13, no. 1, p. 47) reported that Judge George Turner had leased the property and was continuing the lower tunnel. In 1950 Trauerman and Reyner (p. 92-93) listed R. D. Trebolet as leaser of 6 unpatented claims at the Silver King. Development was described as 3,000 feet of drifts and 200 feet of stoping to a height of 80 feet. The lessee reported that he was employing two men and had done a considerable amount of rehabilitation. Shipments of ore were made which were high in lead (table 24).

Records show a total production of 477 tons of ore which yielded no gold, 15,272 ounces silver, 13,089 pounds copper, 110,332 pounds lead, and 5,300 pounds zinc. This is an average grade of 32 ounces of silver per ton, 1.38 percent copper, and 11.57 percent lead. The last two shipments averaged 1.85 percent zinc. Of the three mines in the immediate area the Silver King is the only one that produced lead and zinc.

There are three accessible adits at the mine; however, early accounts mention as many as five. Several caved portals could be seen above the upper adit shown in plates 6A and 6B (in pocket). The lower adit is at an elevation of about 2,600 feet above sea level. The middle adit is 190 feet above the lower, and the upper adit is 185 feet vertically above the middle adit. All three are accessible for their entire length. Many overhand stopes in the upper adit come to surface, but the underhand stopes which are filled with water are of undetermined depth. The raise nearest the portal in the middle adit has been driven upward along a slightly mineralized fault for about 100 feet at the end of which is a short intermediate and small stope. The second raise in the middle adit is only about 30 feet high.

The most productive part of the structure at the Silver King is in and above the upper adit. Here the vein strikes N. 63° W. and dips 41° to 66° SW. The vein is a narrow fracture filling in light-grey quartzite and argillaceous quartzite of the Ravalli Formation. Vein widths range from 1 to 18 inches, but the widths were probably greater in the stope areas because sections of ore 18 inches wide were not mined. A 6-inch channel sample taken 20 feet from the portal of the upper adit contained 0.0015 ounce per ton gold, 36.40 ounces silver per ton, 1.47 percent copper, 3.6 percent lead, 0.6 percent zinc, 0.75 percent antimony, and 0.05 percent bismuth.

The two lower adits were driven along barren faults except for a small lense of ore in a crosscut in the middle adit. Wall rock in the lower adits is essentially thin-bedded medium-grey argillite with some 8- to 12-inch beds of grey quartzite. The wall rocks in all three adits strike northwest and dip at relatively low angles (20° to 47°) northeast.

The mineralized zone along the vein in the upper adit alternates with zones which are predominantly fault clay until, as one approaches the face, vein material gives way completely to fault selvage. Parts of the vein are essentially barren being composed of milky white quartz with minor iron and copper stains. However, the richer portions hold abundant lenses and pods of sulfide minerals throughout the quartz. Breccia fragments are noticeable in the vein but are seldom seen in the fault clay of the lower two adits. The predominantly quartzitic wall rocks in the upper levels are, undoubtedly, more susceptible to brittle fracturing than are the stratigraphically lower argillites.

Mineral assemblage is much the same as for the Raven and Copper King with tetrahedrite being the most common followed by chalcopyrite and pyrite; a few small specks of bornite were observed in the tetrahedrite along with galena and sphalerite. Galena is more abundant than at

TABLE 24.—Production of silver, copper, lead and zinc, Silver King mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
SILVER KING						
1916	31	—	1,397	742	4,637	—
1917	92	—	3,849	3,743	15,594	—
1918	65	—	2,234	1,997	7,448	—
1921	15	—	734	375	2,337	—
1922	5	—	1,140	244	306	—
1923	10	—	334	—	163	—
1924	33	—	1,153	834	26,554	—
1925	33	—	1,964	2,314	19,553	—
1926	13	—	521	586	6,006	—
1928	37	—	976	954	14,504	—
1949	135	—	811	1,000	10,900	4,300
1950	8	—	159	300	2,330	1,000
Total	477	—	15,272	13,089	110,332	5,300

TABLE 25.—Production of gold, silver, copper, lead, and zinc in Trout Creek district, Sanders County, Mont., 1906-61, in terms of recoverable metals.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)	Total Value
1906-07	No production	—	—	—	—	—	—
1908	1	—	2	22	—	—	$ 4
1909-12	No production	—	—	—	—	—	—
1913[1]	22	44	29	—	112	—	924
1914-15	No production	—	—	—	—	—	—
1916[2]	70	4	2	—	—	—	74
1917-38	No production	—	—	—	—	—	—
1939	1	1	8	—	—	—	30
1940	13	25	204	513	3,380	—	1,247
1941	79	12	107	100	300	—	525
1942-61	No production	—	—	—	—	—	—
Total	186	86	352	635	3,792	—	$2,804

1—Includes Gold Hill mine, production listed in Table 26.
2—Includes Canyon Creek mine, production listed in Table 26.

the Raven and occurs as small rounded grains in tetrahedrite (fig. 15). Sphalerite, which was not observed in the ore from the mines across the river, occurs as large irregular grains and is free of inclusions.

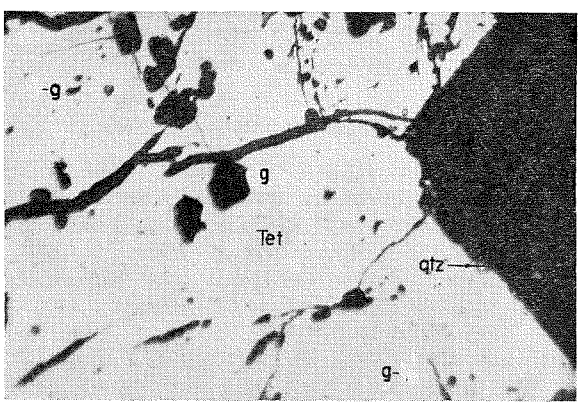

FIGURE 15.—Photomicrograph of ore from Silver King mine, Thompson River mining district (Tet—tetrahedrite; qtz—quartz; g—galena) (240x)

TROUT CREEK DISTRICT

Embracing the drainage system of Trout Creek and lying southwest of the town of Trout Creek is the Trout Creek district which has produced from both placer- and lode-mining properties.

Trout Creek proper drains an area that is largely underlain by the quartzitic sediments of the Ravalli Formation. Blocky talus slopes of white- to dark-grey quartzite can be seen along most of the creek. Near its headwaters and at its mouth the creek cuts slightly calcareous argillites of the Wallace Formation while several of its tributaries drain a narrow anticlinal core of thin-bedded shaly Prichard. One tributary, Granite Creek, cuts a small stock of porphyritic syenite near the Ambassador mine.

Records of lode production indicate a total tonnage of 186 tons from which 86 ounces gold, 352 ounces silver, 635 pounds copper, and 3,792 pounds of lead were recovered. Total value of metals produced in the district is $2,804 or an average value per ton of $15.07. (See table 25.)

Although there is no direct proof, it is believed that the production of several properties listed under Trout Creek district, should be listed in the Vermilion River district. The Canyon Creek mine is thought to be the same as the Copper Ridge on Canyon Creek in the Vermilion district, and a Gold Hill mine is described as being on the Vermilion River in several early mining publications. Production figures for Canyon Creek and Gold Hill mines are shown in table 26.

Between 1913 and 1932 the gravels of Trout Creek and Granite Creek yielded 134 ounces of gold and 12 ounces of silver with a value of $2,770. Except for the year 1932, there is no record of the amount of gravel treated. Therefore, an average value per yard can not be determined. (See table 27.)

TABLE 26.—Production, Canyon Creek and Gold Hill mines. (These properties may be in the Vermilion River district.)

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
	CANYON CREEK					
1913	15	40	28	—	112	—
1916	70	4	2	—	—	—
Total	85	44	30	—	112	—
	GOLD HILL					
1913	7	4	1	—	—	—

Lyden (1948, p. 135, 136) says that at the turn of the century placer claims were being worked on Granite Creek and just below the confluence of the East and West Forks of Trout Creek. He notes that systematic testing may reveal profitable deposits on Granite Creek that could be worked by dry-land dredge. Another area recommended by Lyden for testing at the mouth of the Trout Creek is now inundated by the backwaters of the Noxon Rapids Dam.

Among the placer properties mentioned in early mining magazines are the Driftwood, Ogoma (Maple), Windfall, and Mammy Lou.

TABLE 27.—Production of gold and silver at placer mines, Trout Creek district from 1906-58.

Year	Material Treated (Yd^3)	Gold (oz.)	Silver (oz.)	Total Value
1906-12	No production	—	—	—
1913	—	28	3	$ 572
1914	—	36	4	747
1915	—	31	5	634
1916	—	10	—	212
1917	—	3	—	53
1918-22	No production	—	—	—
1923	—	2	—	39
1924-28	No production	—	—	—
1929	—	2	—	50
1930-31	No production	—	—	—
1932	700	22	—	463
1933-58	No production	—	—	—
Total	700	134	12	$2,770

AMBASSADOR

The Ambassador mine is in the SE¼ sec. 4, T. 23 N., R. 32 W., near the head of Granite Creek, a small northwestward-flowing tributary of Trout Creek. It can be reached by 8½ miles of fair to poor dirt road from the town of Trout Creek southwest and up the East Fork of Trout Creek and Granite Creek.

In October 1929, the Ambassador Mining Co. was organized in Montana to work the property which consisted of 20 unpatented claims. At that time a 350-foot adit had been driven and it was reported that 600 tons of ore had been stockpiled (Mines Register, 1931, p. 1263). Little is known of the company until the Mines Register (1937, p. 21) listed an Ambassador Mines Corp. which was formed in 1936 in Washington for the purpose of operating the Ambassador Mining Co.'s property under lease and bond. A crew of from 8 to 10 men were working at the mine between 1936 and 1940.

In 1949 the Montana Mining Association Newsletter announced that work was proceeding on the crosscut adit and that about 1,500 feet had been completed. The "Newsletter" in 1951 reported that the corporation had been granted a DMEA Loan to diamond drill the property. Still active in 1952 it is reported that the corporation was employing 5 men and that development work was continuing. In the Mines Register, 1956, it was reported that the Sunny Peak Mining Co. had merged with the Ambassador Mines Corp. The new company, at that time, still held 23 claims under lease in the Trout Creek district.

The mine was visited in the summer of 1960 and again in 1961, but entry could not be gained to the main adit which is caved at the portal. Permission to publish the map of underground workings (pl. 5D) was given by the Sunshine Mining Co. Plate 5D shows the adit to be 1,840 feet long, and for most of its length intersects dark-grey quartzitic argillites that generally strike north to northwest and dip to the northeast. An aplite dike with mineralization along its northeast wall was intersected 300 feet from the portal and a steeply inclined stope was mined along this mineralized zone in the large northwest drift. Several narrow dikes and a wide tongue of syenite or monzonite porphyry were also cut by the crosscut adit. The syenite is most likely an offshoot of the Granite Creek stock to the south. The dump contains much coarse-grained syenite that is almost always speckled with pyrite crystals. In addition to the light-colored syenite, several dikes of an unnamed greenish basic rock were cut by the adit.

The production record of the Ambassador mine is shown in table 28.

TABLE 28.—Production of gold, silver, copper, and lead, Ambassador mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (%)	Lead (%)
1939	1	1	8	—	—
1940	13	25	204	513	3,380
1941	79	12	107	100	300
Total	93[1]	38	319	613	3,680

1—Average grade of the total 93 tons is 0.41 ounce gold, 3.4 ounces silver, 0.33 percent copper, and 1.98 percent lead per ton.

E. T. W. (HOMESTAKE)

In the early 1920's the Homestake Mining Co. was developing by adits a wide vein that contained copper ore in kidney-shaped ore bodies (Mining and Scientific Press, 1920, v. 120, p. 653), and by 1924 the company had completed a 900-foot adit (The Mines Handbook, 1924, p. 1221). The same handbook (1931, p. 1311-1319) noted that the E. T. W. Mining Co. had taken over the property which was developed by two tunnels, 654 feet and 725 feet long.

In Mining Truth (v. 12, no. 5, p. 12) the following article appeared:

"* * * is 3½ miles west of Trout Creek, Montana.

"Property is under development by interests that opened Western Union in Revenue Gulch in the Coeur d'Alene and are now in charge of Happy Jack and Paradise in the same locale.

"The ledge at the E. T. W. crosses the top of a high mountain and has an iron capping. The mountain is steep and rugged, affording several good tunnel sites. A shipping point may be reached within a distance of 2½ miles.

"Ledge is in a quartzite formation. The upper tunnel cuts the ledge at a depth of 300 feet. At this point the ledge is 23 feet across. Ore for full width is of high milling quality with a pay streak on the footwall 14 inches wide. This is a true fissure vein with clearly defined foot and hanging wall. Upper tunnel is 654 feet long; 280 feet of drift is on ore body which varies from 19 to 43 feet wide. A winze has been sunk from this level to a depth of 60 feet which exposes ore of higher quality at this depth. A new tunnel is being driven that will strike the ledge at 400 feet

of depth or more; 300 feet of this tunnel is completed."

From the mileage given it may be that this property is the same as the Ruth V patented claim.

RUTH V

The Ruth V patented claim is in NW¼ sec. 24, T. 24 N., R. 32 W., on Trout Creek. At the property there are several caved adits, the dumps of which indicate a considerable amount of development work. A selected sample of iron-stained quartz from the dumps (the only mineralized material that could be found) assayed a trace of gold, 0.2 ounce of silver per ton, 0.3 percent lead, trace of zinc, trace of copper, and 76.2 percent silica.

There is no production record for an E. T. W., Homestake, or Ruth V mine.

OTHER PROPERTIES

Other properties mentioned in various mining magazines as being in the Trout Creek district are the *Arizona* mine, *Monday* group, *Mountain View Mining Co., Trout Creek Mining Co.,* the *Trout Creek Mining and Developing Co.,* and the *Eplin.*

The *Arizona* mine is described as being 8 miles north of the town of Trout Creek. An adit 400 feet long had been driven to intersect a gold-silver-copper vein. Also reported were plans to construct a reduction plant for treating second grade ore with high grade to be sent direct to the smelter (Walsh and Orem, 1912, p. 103).

The *Monday* group was reported to have a 15-foot vein containing an average of $10 in gold, silver, lead, and copper (The Mining World, v. 33, no. 7, p. 291).

The Mining Journal (1929, v. 12, no. 16, p. 40) reported that the *Mountain View Mining Co.* was constructing a mill on its property which contained two veins. The veins, called the Edward and Mountain View, were the objective of a No. 3 tunnel 115 feet long, which had to be driven about 900 feet farther to reach the veins.

The *Trout Creek Mining Co.* was reported to be 250 feet on a 500-foot crosscut that was expected to intersect a 20-foot vein. The vein as exposed in a higher level contained from $18 to $50 in silver, copper, and gold (The Mining World, 1910, v. 33, no. 7, p. 291).

A property that sounds suspiciously like the Ambassador is the *Trout Creek Mining and Development Co.'s* prospect, which was described in the Mining World (1911, v. 34, no. 23, p. 1200) as follows:

"It is stated by people interested in the company's property, 9 miles from Trout Creek, that a highly mineralized zone is now being encountered in the present workings, consisting of a tunnel being driven into the hill. The length is about 350 feet. The values in gold, copper, and silver are found in the face of the present workings. The values lie in rose quartz in the contact of quartzite and granite. Mineralization along the contact can be traced for 1½ miles."

In the Mining World (1911, v. 34, no. 23, p. 1200) a short reference was made to the *Eplin* property, where it is reported a rich strike of copper ore containing galena and gold was made. Location was given as 3 miles from Trout Creek, but the direction was not mentioned. Development was by a 400-foot adit.

VERMILION RIVER (SILVER BUTTE) DISTRICT

Embracing the drainage system of the river, the Vermilion River district is perhaps better known for its placer workings than it is for lode mines.

The river, for about 10 miles from its headwaters, flows northward through a massive series of calcareous argillites of the Wallace Formation which forms the northern core of the Cabinet anticline. Along this stretch of the river, the canyon parallels, or nearly so, the strike of the formation. It then swings to an almost westerly direction and crosscuts Ravalli and Prichard Formations and a stock of Cretaceous syenite near the river's mouth.

Along the Vermilion River, the Ravalli Formation is composed of light-colored sericitic quartzite and light-grey argillaceous quartzite near the top of the formation, but it becomes darker colored near its contact with the Prichard Formation. The Prichard is generally composed of medium- to dark-grey thin-bedded argillites with some interbedded quartzite.

The syenite stock at the mouth of the river is generally very coarse grained and is composed of pinkish orthoclase, hornblende, and biotite with varying amounts of plagioclase and titanite. Quartz is a minor component. The northern edge of the stock is abruptly terminated along the Snowshoe fault. Consequently the stock abuts Prichard argillites along a rather straight northwest line. The fault with an inferred throw of 6,000 to 10,000 feet is the main structure along which the ore body of the Snowshoe mine in Lincoln County was found. According to Sahinen (1949) the Copper Ridge prospect is just to the east of the Snowshoe fault, and mineralization is probably related to minor faults along the lengthy Snowshoe break.

The best known mine in the district is the Silver Butte or Carpenter mine at the head of Lyons gulch. The Silver Butte contains lead, zinc, and silver mineralization, but the rest of the district is known mostly for gold—placers and lode. The lode mines are largely abandoned and inaccessible, but the placers are still being actively worked.

Production of lode mines in Vermilion district is shown in table 29.

TABLE 29.—Production of gold, silver, copper, lead, and zinc in terms of recoverable metals, in Vermilion River district, Sanders County, Mont. (Includes production from Golden Reef, Razorback, Shoe String, and Tincup, which, according to local people, are in Lincoln County.)

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)	Total Value
1906-33	(no production)						
1934	15	4	—	—	—	—	$ 144
1935-36	(no production)						
1937	5	2	21	33	508	—	98
1938	(no production)						
1939	15	13	25	—	—	—	445
1940	275	66	97	—	—	—	2,379
1941	123	52	118	100	300	—	1,933
1942	269	76	97	—	—	—	2,729
1943[1]							
1944-58	(no production)						
Total	702	205	358	133	808	—	$7,728

1—Figures cannot be revealed.

Placer diggings are evident along much of the lower river, and several abandoned washing machines may be seen between Cataract and Canyon Creeks. During the late summer of 1961 the Vermilion Gold Co. (?) was testing ground on the river near the mouth of Cataract Creek with a unique pile-driver type of drill. Samples of gold recovered by the company from test shafts proved to be coarse and angular, attesting to the short distance much of it had traveled.

According to Lyden (1948, p. 136) placer claims along the Vermilion have yielded gold since 1904, but statistics show no production until 1933 when 61 ounces of gold was recovered. Between 1933 and 1946 a total of 434 ounces of gold and 74 ounces of silver, valued at $14,341, were recovered from 34,085 yards of material (table 30) or an average value of 42 cents a yard. Lyden (1948, p. 138) advances the opinion that a considerable amount of gravel still exists along the river that could be worked profitably by dryland or dragline dredges. He continues thusly,

"The gold in the placer gravels of Vermilion Creek has been derived primarily from the quartz veins carrying free gold some of which were developed as far back as 1894. Unlike the placer gold of Trout Creek, that in Vermilion Creek is probably of three ages. The oldest would be gold that formed placers in Vermilion Creek prior to the Pleistocene glaciation; this would be followed in age by that gold scoured from the veins as the ice sheet flowed over the divide from the east and down the valley, at that time incorporating the pre-existing placer gravels into its till. The youngest placer gold has weathered from the veins since the withdrawal of the ice sheet many millions of years ago.

"The placers worked today will contain gold reconcentrated from the glacial gravels (possibly some being carried over the divide from the lode deposits on the headwaters of Fisher River) and some gold weathered from the veins since the Pleistocene glaciation."

TABLE 30.—Production of gold and silver from placer mines, Vermilion River district.

Year	Material Treated (Yd^3)	Gold (oz.)	Silver (oz.)	Total Value
1906-32	No production	—	—	—
1933	2,559	61	17	$ 1,263
1934	—	108	17	3,779
1935	6,650	73	14	2,573
1936	3,756	36	5	1,250
1937	2,891	24	9	847
1938	4,462	22	—	770
1939	2,825	15	—	525
1940	4,200	27	—	945
1941	1,592	31	7	1,090
1942	150	5	—	175
1943-45	No production	—	—	—
1946	5,000	32	5	1,124
1947-58	No production	—	—	—
Total	34,085	434	74	$14,341

COPPER RIDGE

The following description of the Copper Ridge is extracted from Sahinen (1949):

The Copper Ridge is in sec. 25, T. 25 N., R. 31 W., near the head of the West Fork of Canyon Creek, a tributary to the Vermilion River. The main workings, which are on Copper Ridge, lie at an elevation of 5,000 to 5,160 feet above sea level. The property is reached by dirt road from Trout Creek up the Vermilion River and then by trail along Canyon Creek.

During the early 1880's the prospect was discovered and a mill was constructed about half a mile below the main workings. The mill burned but was rebuilt in 1897 as a stamp mill. In the 1930's the unpatented claims were relocated by P. O. Brende of Clark Fork, Idaho, and additional development work was done. Development, in 1949, was by five adits and an inclined shaft. The adits were driven into the steep slope of Copper Ridge in a westerly to northwesterly direction. From the lowest (No. 1) to the uppermost (No. 5) the adits are 180, 185, 80, 260, and 110 feet long. Adit No. 1 did not encounter any mineralization. It was driven through bluish-grey blocky argillite. Adit No. 2 intersected two northwest-trending faults that dip steeply to the southwest. Only 80 feet long, adit No. 3 cuts a quartz fissure vein

that strikes about N. 50° E. and dips 45° to 60° SE. The vein is composed of crushed and iron-stained argillite with quartz and limonite. Average dollar-value in gold of five samples taken across the 1-foot vein is $8, but one sample ran as high as $19.60 in gold (0.56 ounce per ton). This is reported to be the highest grade showing on the property. Adit No. 4, slightly lower in elevation than No. 3, branches to a "Y" shape. The northwest crosscut cuts a 1-foot vein at 55 feet which strikes N. 10° W. and dips steeply northeast. The northwest drift follows a narrow 1-foot quartz vein which is composed of crushed argillite and iron-stained quartz. The highest assay of this vein is 0.21 ounce gold per ton or $7.35. Several other minor veins were intersected in short crosscuts from the drift but gold values were only slightly above $1. The uppermost adit No. 5 exposes an 18-inch iron-stained quartz vein. Some high-grade ore was mined from a raise connecting No. 4 and No. 5 adits, but the amount is not known. A sample from the north end of the old stope carried $14.35 in gold (0.41 ounce per ton). Another sample 60 feet from the portal on the same vein contained only $0.35 in gold.

The inclined shaft follows a bedding-plane vein, 6 to 12 inches wide, which strikes N. 20° E. and dips 18° to 20° NW. An assay revealed only $0.35 in gold.

SILVER BUTTE (CARPENTER, VERMILION)

The Silver Butte mine is at the head of Lyons Creek, a southeast-flowing tributary of the Vermilion River. Six patented claims known as the Dominion group, three of which are named the Roscoe, Daly, and Dominion, are in parts of sec. 15, 16, 21, and 22, T. 25 N., R. 30 W. (See fig. 16). Three of the six claims cross the county line between Sanders and Lincoln Counties. Present owners are T. H. Erickson and Mrs. Lou Davidson. The mine is reached by following the dirt road up Vermilion River and Lyons gulch and then along an old wagon road, which follows the northernmost branch of the creek. The wagon road is impassible for vehicles.

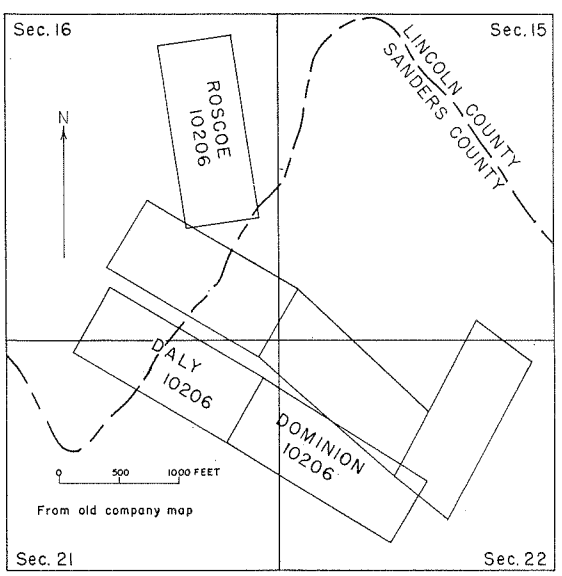

FIGURE 16.—Claim map of the Dominion group, Vermilion River mining district (T. 25 N., R. 30 W.)

MacDonald (1906, p. 50) first described the Silver Butte mine, which had been opened on a persistent quartz vein in blue Prichard slate. The vein strikes N. 30° W., dips 30° SW., averages about 10 feet in width, and contains galena scattered through lenses of white quartz. MacDonald also mentions a $150,000 concentrating plant in which some ore had been milled, but added that while temporarily closed the mill burned and the mine had been idle since that time. He continued that the property was located on a strong vein which contained enough values to indicate that additional development might open sufficient low-grade silver-lead ore to make the property a regular producer.

In 1912 Walsh and Orem (p. 103) noted that the Vermilion Gold and Silver Mining Co. owned the Dominion group which had been developed by a series of tunnels. The ore carried "high values in gold, lead, and copper; gold predominating."

The Mining and Scientific Press (1912, v. 104, no. 26, p. 904) said that the Vermilion Silver and Lead Co. was operating the property and had opened an adit level on a 7-foot vein. The vein with a streak of shipping ore about 20 inches wide was said to average about $20 per ton across its entire width.

In 1919 the Minerals Yearbook noted that the Vermilion Silver and Lead Mining Co. had done 500 feet of tunnel work and that there was a 100-ton mill on the property. Between 1920 and 1928 the property was operated intermittently and several reports mention leasing operations and other companies that had optioned the mine. The Associated Metals Corp. and the Anaconda Lead Mining Co. were noted in connection with the mine (The Mining Journal, 1928, v. 12 no. 4, p. 42). Some references refer to the mine as the Kentucky-Vermilion (Mining Truth, 1928, v. 13, no. 11, p. 3).

Again in 1931 the Vermilion Silver and Lead Mining Co. was listed as the operating company. Development at that time consisted of three tunnels, 30, 500, and 1,000 feet long. It was also announced that the president, R. C. Carpenter, and associates had taken over the mine on a lease and option and planned to form the Lyons Creek Development Co.

In 1937 and 1938 the mine was reopened by P. J. Lucier and Sons. A flotation mill, rated at 50 tons per day was being re-equipped and repaired and roads were being reopened (The Mining Journal, 1938, v. 22, no. 1, p. 26). The

mine was called the Vermilion Metals mine by Trauerman (1940, p. 100) at that time. Between 1940 and 1946 three different companies were listed as the operators of the Silver Butte mine. In 1940 it was reported that the Silver Butte Mines Co. had planned to begin shipments in 1939 (Mines Register, 1940, p. 488). In 1942 the Fitsum Mining Co. of Idaho held the mine under lease from Silver Butte Mines, Inc. (Mines Register, 1942, p. 121). The Silver Butte Zinc and Lead Mining Co. was operating the mine and constructing a 50-ton mill in 1946 (Mines Register, 1946, p. 254).

During an examination of the mine in 1961, one adit could be followed for about 750 feet, but the rest of the property, such as mine roads, buildings, and mill, was in poor repair.

The adit for most of its length follows a narrow fault through thin-bedded and banded light- to dark-grey, and black quartzitic argillite of the Ravalli Formation. Along the narrow fault there are discontinuous 1-inch to 1-foot veins, but rarely do the veins contain more than a few scattered grains of sulfide minerals. About 750 feet from the portal the adit intersects a wide bedding-plane quartz vein which nearly parallels the trend of the adit. The vein is from 5 to 6 feet wide, strikes N. 15° E. and dips 70° SE. along the bedding planes. Length of the ore shoot could not be determined. Sulfide minerals—pyrite, chalcopyrite, galena, and sphalerite—though not abundant, are distributed rather evenly through massive white quartz. A muck-pile sample beneath the beginning of a raise contained 0.05 ounce gold and 0.4 ounce silver per ton, and 0.28 percent copper, 1.30 percent lead, and 1.30 percent zinc. Arsenic was not detected by chemical analysis.

Although the mineralization at the observable portion of the ore shoot occurs as evenly distributed small grains in quartz, other portions of the vein apparently contain larger pods of the sulfide minerals. Samples from the ore shoot are composed principally of quartz, galena, sphalerite, pyrite, and chalcopyrite, but there is little interlocking between minerals and rarely does one mineral contain abundant inclusions of another. In the massive samples collected from the ore bin and dump, tetrahedrite is a relatively common mineral. It occurs almost always with chalcopyrite. Sphalerite with large concentrations of chalcopyrite exsolution blebs usually is veined by tetrahedrite (fig. 17), and galena with included grains of chalcopyrite also contains rounded blebs of tetrahedrite. Areas of the vein rich in chalcopyrite could, therefore, be expected to be relatively rich in silver.

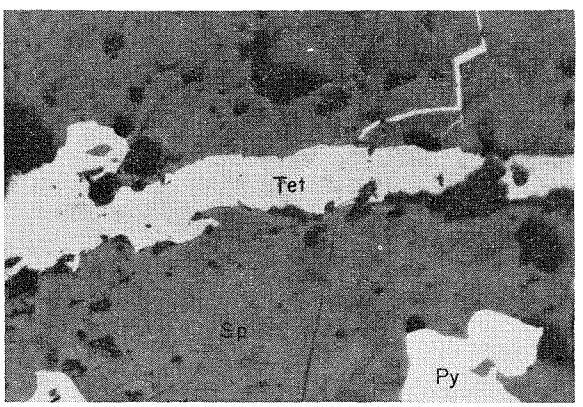

FIGURE 17.—Photomicrograph of ore from Silver Butte mine, Vermilion River mining district (Tet—tetrahedrite; Sp—sphalerite; Py—pyrite) (270x).

OTHER PROPERTIES

Several other mining companies have been described in the literature. Between 1910 and 1912 The Gold Hill Mining Co., also referred to as Heater and Co. or Harfort group, was developing a group of claims on the Vermilion River. It is reported that a well defined low-grade vein was opened by adits and a 50-ton mill had been constructed (Mining World, 1910, v. 33, no. 7, p. 291, and 1911, v. 34, no. 23, p. 1200; Walsh and Orem, 1912, p. 104). It is believed that the property referred to is about a mile and a half up the Vermilion River and on the east bank. The remains of an old mill and ore bin can be seen here, but the underground workings are apparently obliterated.

In 1939 the Mining Journal (v. 22, no. 11, p. 24) reported on a Gold Lode Mining Co. that was installing a stamp mill on Vermilion River. Trauerman (1940, p. 99) lists this company and added that the property consisted of two patented and two unpatented claims in the Vermilion River district. It was also reported that the mine was developed by tunnels and about 25 tons of gold-bearing quartz was being mined per day. The only *Gold Lode* production in Sanders County is recorded under the Prospect Creek district where it is reported that in 1940, 20 tons of ore was produced which yielded 8 ounces of gold and 11 ounces of silver. The gold produced and the name similarity leads one to believe that both mentioned properties are one and the same.

In 1891 Swallow and Trevarthen (p. 71) noted that some of the mines on Vermilion Creek were developing gold-bearing quartz veins that cut granite. The *Missoula Mining Co.* had installed a 10-stamp mill and had made 2 short runs, but the results were unknown. This sounds similar to the Copper Ridge property.

WHITE PINE (EAGLE, BEAVER CREEK) DISTRICT

The area drained by the Big Beaver Creek west of Belknap is known as the White Pine (Eagle, Beaver Creek) mining district. During the 1890's and early 1900's a trail up Beaver Creek was one of the main routes to Murray, Idaho.

TABLE 31.—Production of gold, silver, copper, lead, and zinc, 1906-61, in terms of recoverable metals, White Pine (Eagle, Beaver Creek) district, Sanders County, Mont.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)	Total Value
1906-10	No production	—	—	—	—	—	—
1911[1]	247	4	1,494	1,126	302,652	—	$ 14,627
1912[1]	506	8	2,378	—	567,414	—	27,161
1913-15	No production	—	—	—	—	—	—
1916[1]	69	1	368	—	52,684	—	3,901
1917[1]	1,644	30	5,902	—	1,356,946	—	122,189
1918[1]	209	3	720	—	157,047	—	11,934
1919[1]	177	3	620	348	117,424	—	7,042
1920[1]	343	4	1,527	—	365,912	—	31,021
1921	No production	—	—	—	—	—	—
1922[1]	67	—	387	183	80,198	—	4,823
1923[1]	224	—	1,501	—	271,772	—	20,255
1924-25	No production	—	—	—	—	—	—
1926[1]	7,454	—	4,729	334	1,084,027	—	89,720
1927[1]	20,384	—	10,196	4,783	2,350,847	—	154,511
1928[1]	20,289	53	11,008	8,222	2,036,715	790,000	175,043
1929[1]	34,140	78	19,810	25,903	4,360,831	525,000	326,104
1930[1]	33,831	106	25,462	39,754	6,044,454	85,134	323,465
1931[1]	74,128	128	46,714	59,966	9,873,566	854,898	420,534
1932[1]	8,420	25	7,862	8,825	1,568,667	36,367	52,042
1933[1]	14,699	53	15,860	8,406	3,235,784	204,310	135,505
1934	28,762	104	25,706	18,400	5,119,946	763,163	243,969
1935	11,153	22	9,440	12,024	2,241,675	230,068	108,344
1936[1]	37,396	70	30,714	32,848	6,941,804	1,590,540	428,096
1937[1]	50,458	87	41,885	61,281	10,480,899	1,372,400	750,437
1938[1]	52,684	85	41,744	44,296	10,145,696	1,307,417	563,760
1939[1]	47,691	74	33,131	39,173	8,378,788	1,019,346	475,962
1940[1]	44,476	72	36,599	53,168	8,460,780	851,460	511,235
1941	27,223	76	32,483	18,800	6,588,900	2,095,000	560,669
1942	23,195	38	20,025	17,000	3,997,600	696,000	350,194
1943	18,945	30	15,421	43,500	3,160,400	512,500	310,051
1944	9,931	17	10,350	22,200	2,256,100	183,500	212,359
1945	4,690	9	5,580	11,400	1,197,500	207,000	132,612
1946	3,814	8	4,052	13,500	938,000	170,500	128,784
1947	3,552	9	4,032	16,800	786,000	253,800	149,863
1948	3,997	13	5,824	16,000	1,199,500	251,800	257,399
1949	5,743	20	8,436	12,500	2,047,700	304,000	372,030
1950	7,198	19	8,932	14,000	2,026,800	352,900	335,391
1951	7,325	19	6,993	18,000	1,450,000	548,000	361,936
1952	9,451	21	7,707	20,000	1,466,000	882,000	394,988
1953	8,951	37	11,954	26,000	2,358,000	888,000	430,594
1954	9,833	22	12,774	35,600	2,236,300	916,400	428,177
1955	6,478	16	9,102	23,600	1,411,300	489,000	288,778
1956	7,620	25	12,344	31,600	2,414,300	796,400	513,629
1957	10,079	32	19,615	77,600	3,506,900	771,200	633,177
1958	9,480	24	14,974	94,000	2,818,000	268,000	396,156
1959	13,602	25	18,844	75,200	3,975,200	227,400	524,315
1960	5,374	27	9,341	18,700	1,996,500	257,500	282,210
1961	1,601	1	3,064	14,000	540,000	151,400	80,099
Total	687,539	1,550	617,604	1,041,040	133,967,528	20,872,403	$12,145,096

1—Includes production from the Jack Waite mine which was credited to Eagle district, Shoshone County, Ida.

The creek drains an area underlain by Prichard, Ravalli, and Wallace Formation rocks. The Prichard crops out on the divide to the west and is the host rock at the Jack Waite mine. Ravalli Formation sediments occur along the middle portion of the creek and are overlain by northeast-dipping argillites of the Wallace Formation near White Pine and Belknap.

The only mine of importance in the district is the Jack Waite and the one other property visited, the Royal Copper, was caved and abandoned. Lode production of the district is shown in table 31.

JACK WAITE

The disregard that nature displays for man-made boundaries is well shown at the Jack Waite mine where mineralization, and thus mining, cross the Montana-Idaho State Line. Although the main surface plant of the mine is on Tributary Creek, a branch of the East Fork of Eagle Creek, in Idaho, much of the mining since the 1930's has been in Montana on the Dixie Creek branch of Big Beaver Creek. In Idaho, the mill and surface plant is in S½ sec. 19, T. 50 N., R. 6 E., Idaho meridian, and in Montana the company's patented ground covers parts of the SE¼ sec. 17, T. 22 N., R. 32 W., Montana meridian.

According to Hosterman (1956, p. 742) the outcrop of the Jack Waite vein was discovered in the early 1900's by Jack Waite who was making a trip from Belknap, Montana, to Murray, Idaho. At that time one of the main routes

to Murray was up Beaver Creek to the divide and then down Butte Creek in Idaho. Near the divide Waite lost his way and started down Tributary Creek where he discovered the vein.

The Jack Waite Mining Co. was incorporated in 1909 and at that time purchased the property, which consisted of nine claims, from Senator Lee Mantle of Montana for a reported $250,000 (Wallace Miner, Feb. 22, 1962).

Prior to 1927 the mine's development had been sporadic because of poor roads, high zinc content, and the lack of milling equipment. However, in 1927, under the management of the Jack Waite Leasing Co. a 125-ton mill and an electric power line were built, and underground reserves were increased (Mining Truth, 1927, v. 12, no. 5, p. 19). By 1928 work had started on the main haulageway, the 1,500-foot level, which was eventually driven to the Jack Waite extension, or Silver King property on the Montana side. At the same time it is reported that the mill capacity was to be enlarged to 400 tons per day. The operating company was called Jack Waite Consolidated. American Smelting and Refining Co. took over the operation of the mine under lease in May of 1934 and operated the mine until 1961 when they relinquished their lease. At last report, February 1962, the mine was being operated by private lessors.

From 1911 to 1961 total production at the Jack Waite is 687,425 tons, with a recoverable metal content of 1,549 ounces gold, 616,615 ounces silver, 1,035,240 pounds copper, 133,953,045 pounds lead, and 20,871,892 pounds zinc. (See table 32.) Average grade of this total amount is 0.0022 ounce gold per ton, 0.88 ounce silver per ton, 0.069 percent copper, 9.5 percent lead, and (since 1928) 1.59 percent zinc.

TABLE 32.—Production of gold, silver, copper, lead, and zinc, 1911-61, in terms of recoverable metals, Jack Waite mine, Eagle district, Sanders County, Mont.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)	Lead (lb.)	Zinc (lb.)
1911[1]	247	4	1,494	1,126	302,652	—
1912[1]	506	8	2,378	—	567,414	—
1916[1]	69	1	368	—	52,684	—
1917[1]	1,644	30	5,902	—	1,356,946	—
1918[1]	209	3	720	—	157,047	—
1919[1]	177	3	620	348	117,424	—
1920[1]	343	4	1,527	—	365,912	—
1922[1]	67	—	387	183	80,198	—
1923[1]	211	—	1,440	—	258,589	—
1926[1]	7,454	—	4,729	334	1,084,027	—
1927[1]	20,384	—	10,196	4,783	2,350,847	—
1928[1]	20,289	53	11,008	8,222	2,036,715	790,000
1929[1]	34,140	78	19,810	25,903	4,360,831	525,000
1930[2]	33,831	106	25,462	39,754	6,044,454	85,134
1931[2]	74,128	180	46,714	59,966	9,873,566	854,898
1932[2]	8,420	25	7,862	8,825	1,568,667	56,367
1933[2]	14,699	53	15,860	8,406	3,235,784	204,310
1934	28,762	104	25,706	18,400	5,119,946	763,163
1935	11,153	22	9,440	12,024	2,241,675	230,068
1936[2]	37,396	70	30,714	32,848	6,941,804	1,590,540
1937[2]	50,458	87	41,885	61,281	10,480,899	1,372,400
1938[2]	52,684	85	41,744	44,296	10,145,696	1,307,417
1939[2]	47,691	74	33,131	39,173	8,378,788	1,019,346
1940[2]	44,476	72	36,599	53,168	8,460,780	851,460
1941	27,223	76	32,483	18,800	6,588,900	2,095,000
1942	23,195	38	20,025	17,000	3,997,600	696,000
1943	18,945	30	15,421	43,500	3,160,400	512,500
1944	9,931	17	10,350	22,200	2,256,100	183,500
1945	4,690	9	5,580	11,400	1,197,500	207,000
1946	3,814	8	4,052	13,500	938,000	170,500
1947	3,552	9	4,032	16,800	786,000	253,800
1948	3,997	13	5,824	16,000	1,199,500	251,800
1949	5,743	20	8,436	12,500	2,047,700	304,000
1950	7,198	19	8,932	14,000	2,026,800	352,900
1951	7,310	19	6,916	17,000	1,449,400	547,689
1952	9,451	21	7,707	20,000	1,466,000	882,000
1953	8,933	36	11,524	25,600	2,357,300	888,000
1954	9,771	22	12,353	31,200	2,236,300	916,200
1955	6,478	16	9,102	25,600	1,411,300	489,000
1956	7,620	25	12,344	31,600	2,414,300	796,400
1957	10,079	32	19,615	77,600	3,506,900	771,200
1958	9,480	24	14,974	94,000	2,818,000	268,000
1959	13,603	25	18,844	75,200	3,975,200	227,400
1960	5,374	27	9,341	18,700	1,996,500	257,500
1961	1,601	1	3,064	14,000	540,000	151,400
Total	687,425	1,549	616,615	1,035,240	133,953,045	20,871,892

1—Production credited to Eagle district, Shoshone County, Ida.
2—Includes production credited to Eagle district, Shoshone County, Ida.

The mine has been described by Hosterman (1956, p. 742) as follows:

"The mine has about 24,000 feet of drifts and crosscuts and several thousand feet of raises and winzes. (See fig. 18.) The mine is divided in half by the Idaho-Montana State line; both sides can be reached through the adit of the 1,500 level which has its portal about one-half mile upstream from the town of Duthie (Idaho). The Idaho side, now inaccessible above the 1,500-foot level, was at one time open through an adit on the 1,000 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 1,500 level and out to the mill at Duthie. Workings below the 1,500 level on both the Idaho and Montana sides are under water." (See pl. 5E.)

Mineralization at the Jack Waite follows a strong shear zone that strikes about N. 60° W. and dips 45° to 55° SW. The zone is persistent. It has been exposed for 5,500 feet on the 1,500-foot level and is known for 1,700 feet along the dip. Ore shoots within the zone are as large as 1,000 feet, generally rake southeast, but a few are elongate downdip. Although the average stope width is about 5 feet, the vein ranges in width from 1 inch to 12 feet (Hosterman, 1956, p. 742-743).

Turner (1931, p. 672) classifies two veins at the Jack Waite: the high-grade Montana vein, which is most prominent in the eastern portion of the structure and which usually occurs along the hanging wall, and the Idaho vein which is less intensely mineralized along the footwall. At some places a horse of waste separates the two; the distinction between the two is not as noticeable in other parts of the mine.

The junction between secondary shears and the main Jack Waite fault are considered to have played a part in localizing ore shoots along the main structure according to Hosterman (1956, p. 743). However, Jenks (1938, p. 210) believes that the ore shoots are controlled by minor deviations in the direction of the vein and cites as an example the Montana stope, which lies just to the southeast of a change in strike of the main structure.

Cross-vein faulting is not mentioned in any of the cited publications, but some post-mineralization movement has occurred within the vein as evidenced by zones of sheared and crushed galena (Hosterman, 1956, p. 743).

Country rock is described as being part of the lower Prichard Formation slates that dip at low angles 20° to 40° NE. Turner also mentions that some silica has been added to the slates, probably at the time of mineralization.

The low-silver ores of the Jack Waite contain siderite, quartz, and breccia fragments of country rock as gangue. The sulfide minerals are pyrite, sphalerite, tetrahedrite, chalcopyrite, galena, pyrrhotite, and cosalite. Deposition is believed to be in the sequence given. Siderite, which is less abundant than quartz, was the first mineral deposited. The most abundant mineral is galena. The galena masses enclose many small grains of other sulfides. Sphalerite, the next most abun-

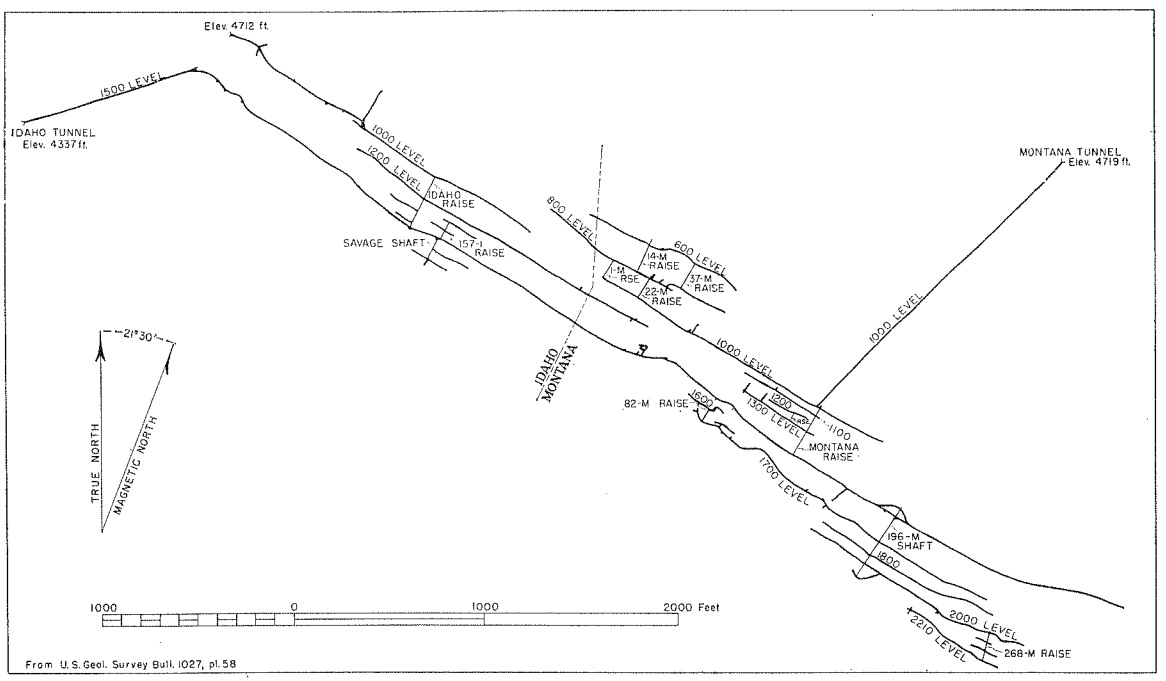

FIGURE 18.—Composite map of workings, Jack Waite mine, Sanders County, Mont., and Shoshone County, Ida. (Montana Sec. 17, T. 22 N., R. 32 W; Idaho Sec. 19, T. 50 N., R. 6 E.)

dant sulfide, is coarsely crystalline and is veined by galena. The other sulfides are of minor importance (Jenks, 1938, p. 210-212). This is quite apparent, in the case of tetrahedrite, from the average grade of 0.88 ounce of silver per ton. Perhaps, again this bears out the general statement pertaining to mines in Sanders County that where the high-temperature mineral pyrrhotite occurs, there is usually a noticeable deficiency of tetrahedrite and low silver content. Cerussite and pyromorphite have also been noted in Jack Waite ores (Umpleby and Jones, 1923, p. 85).

LUCKY LUKE (ROYAL COPPER, L & N)

This is one of those properties about which little is known. Early reports (1909) on the mine give its location as 4 miles north of Belknap and name the district the Seepay or Sleepy Creek district. Available maps of the area near Belknap do not show a Seepay or Sleepy Creek. However, the Mines Handbook (1931, p. 1353) reported that the Royal Copper Mining Co., Ltd., property had been taken over in 1926 by the Lucky Luke Mining Co., and the U. S. Geological Survey Thompson Falls topographic map shows a Lucky Luke mine in SE¼ sec. 18, T. 22 N., R. 30 W., about 4 miles west of Belknap. Production records retain the district name Sleepy Creek, but for the purpose of this report, the mine will be included in the White Pine (Eagle, Beaver Creek) district.

The Royal Copper Mining Co., Ltd., in 1909, was said to be developing a property by a 463-foot crosscut adit that contained a vein averaging 6 percent copper, 18 percent lead, and a small amount of silver (The Copper Handbook, 1909, p. 1193).

The 1910-1911 issue of the same book (p. 1499) reported that the company was developing an 18-foot vein by two separate adits 50 and 600 feet long. The company held 12 claims at that time.

In 1926 the Royal Copper mine was credited with production of 51 tons of ore which yielded 1 ounce gold, 44 ounces silver, and 5,631 pounds of copper. (See table 33.) When the Mines Handbook (1931, p. 1353) reported that the Lucky Luke Mining Co. had acquired the property it also noted that two cars of copper ore had been shipped, but there is no record of such production at that time.

TABLE 33.—Production of gold, silver, and copper, Royal Copper mine.

Year	Ore (tons)	Gold (oz.)	Silver (oz.)	Copper (lb.)
1926	51	1	44	5,631

When visited in the summer of 1960 all workings were inaccessible. The dumps were composed mainly of light-tan quartzite and dark-grey argillite with a few scattered pieces of iron-stained quartz. Several small flecks of galena were noticed in some specimens. From the size of the dumps it is estimated that there is about 1,000 feet of underground workings.

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