STATE OF IDAHO
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IDAHO BUREAU OF MINES AND GEOLOGY
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GEOLOGY AND METALLIFEROUS DEPOSITS
OF KOOTENAI COUNTY, IDAHO

By
Alfred L. Anderson

Prepared in cooperation with
the United States Geological Survey

University of Idaho
Moscow, Idaho
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GEOLoGY AND METALLIFEROUS DEPOSITS
OF Kootenai County, Idaho

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Alfred L. Anderson

ABSTRACT

Kootenai County is in the northern part of Idaho between Shoshone County (the seat of the famous Coeur d'Alene mining district) and the Washington state line, and is best known for its lumbering, scenic, and agricultural industries. Much of the county is contained in the Coeur d'Alene and Selkirk mountains, and the only land of low relief is an embayment of the Columbia Plateau and the essentially flat-bottomed floor of the Purcell Trench, which separates the Coeur d'Alene Mountains on the east from a part of the Selkirks on the west. The county is famous for its many lakes, the largest of which, Coeur d'Alene, Hayden, Spirit, Twin, and Hauser lakes, border the Purcell Trench behind dams of glacial outwash which has raised the floor of the trench above the level of entering stream valleys. Many smaller lakes border the lower flood-plain of the Coeur d'Alene River, held back by the aggraded floor of the main valley.

In the Coeur d'Alene Mountains, in which most of the metalliferous deposits occur, the prevailing country rock are strata of the Belt series (pre-Cambrian), which in places are invaded by relatively small bodies of igneous rocks of diverse kind and age. The Belt series include all members of the Coeur d'Alene district, the Prichard, Burke, Ravett, St. Regis, Wallace, and Striped Peak formations, some of which differ in minor detail from the equivalent formations in the type locality. The oldest member, the Prichard, contains some altered diorite or gabbro sills, correlated with the Purcell sills of late pre-Cambrian age. Some infaulted Cambrian quartzite and limestone are preserved with the Belt formations along the northwest margin of the Coeur d'Alene Mountains bordering Pend Oreille Lake. Bodies of granodiorite of considerable size intrude the strata along the northwest margin of the Coeur d'Alene Mountains. These bodies are correlated with the Nelson batholith and are believed to have been intruded during late Jurassic or early Cretaceous time. Smaller bodies composed of a notably different kind of rock are grouped along a west-northwest zone extending across the mountainous area from Shoshone County. These include a small stock of porphyritic quartz monzonite, numerous dikes of diabase, other basic rocks shading into lamprophyre, and dikes of diorite, monzonite, and granite and rhyolite porphyry. The intrusives were implanted at relatively shallow depth, probably during the early part of the Tertiary. Other rocks of the area include flows of Columbia River basalt, intercalated beds of Late formation (Miocene), late Tertiary terrace gravels, Pleistocene glacial deposits, and Recent alluvium.

The Selkirk Mountains are carved in gneissic granitized sedimentary rocks, mostly granite gneisses, formed by and during batholithic intrusion (Nelson batholith). The Columbia Plateau is underlain by Columbia River basalt, the Purcell Trench by Pleistocene till and outwash.

The Belt and Cambrian strata have been much disturbed by folding and faulting. Near the granodiorite bodies along the northwest margin of the Coeur d'Alene Mountains, the beds have been broken into a mosaic of fault blocks associated with igneous intrusion and collapse. The dominant structural feature of the region, however, is a broad, much faulted, anticlinal uplift of west-northwest trend, which extending in an east-southeast direction into the Coeur d'Alene district, has its central part invaded by dikes of diabase, rhyolite and granite porphyry, and by rocks of intermediate composition. The crest and flanks of the broad anticline
have been broken by longitudinal faults of large magnitude of which the Osburn, Placer Creek, and Burnt Cabin faults are outstanding and are among the most famous in north Idaho. The uplift has also been broken by transverse faults of lesser magnitude, and in places by mosaic block faults of minor magnitude. Mineralization has been associated with the intrusion, and mineral deposits are scattered along the crest and flanks of the uplift, particularly along the zones of the major longitudinal faults. The structural relations are apparently those associated with collapse of the anticlinal uplift and concurring igneous activity.

The faulting along the western border of the Coeur d'Alene Mountains appears to have accompanied the intrusion of the Jurassic or Cretaceous granodiorite, but the much faulted anticlinal structure is apparently younger and is probably related to late Cretaceous or early Tertiary crustal movements.

The metalliferous deposits comprise a group of fissure veins largely filled with quartz and a second group of replacement deposits of somewhat younger age. The fissure veins are the most widely distributed and contain, in addition to quartz, variable but usually small amounts of sulphides in generally widely-scattered grains, granules, and bunches. According to the metals present, these veins may be classed as (1) chalcopyrite-quartz veins, (2) lead-zinc-quartz veins, (3) silver-quartz veins, (4) bismuth-quartz veins, and (5) quartz veins. A small production has come from a silver-quartz vein, but others have not disclosed ore in commercial quantities.

The replacement deposits also include a number of different types, and may be classed as (1) lead-zinc-pyrrhotite deposits, (2) arsenopyrite deposits, (3) lead-zinc-siderite deposits, (4) siderite deposits, (5) lead-silver deposits, (6) specularite-ankerite deposits, and (7) specularite-baryte deposits. Unlike the fissure fillings, these contain but very minor amounts of quartz. The lead-zinc-pyrrhotite deposits are along broad zones of fractured and intensely-altered rock; but the sulphide zones are usually from 3 to 5 feet thick and consist largely of massive pyrrhotite containing small, scattered, irregular shoots of lead-zinc ore. Some production has come from them. Only one lead-zinc-siderite deposit has so far been uncovered. It occurs as a replacement along an intensely fractured and sericitized zone under conditions similar to those which attended the deposition of the commercial ores in the Coeur d'Alene district.

The lead-zinc pyrrhotite and arsenopyrite deposits are hypothermal and occur generally along the central part of the broad, anticlinal uplift near bodies of intrusive rocks. The lead-zinc-siderite and other deposits are grouped along the flanks of the uplift some distance from exposed, intrusive rocks. These were formed under lower temperatures than the lead-zinc-pyrrhotite deposits; namely, under mesothermal conditions.

Future exploration might well be directed toward the discovery of lead-zinc-siderite deposits rather than toward the development of the quartz veins. The former have very inconspicuous outcrops in contrast to the quartz veins which are easily detected on the surface. There is no evidence that the lead-zinc-pyrrhotite deposits will show increased amounts of lead and zinc with depth, although they may continue to considerably lower levels with little change.
INTRODUCTION

PURPOSE AND SCOPE

This report embodies the results of a geologic study of the mineral deposits of Kootenai County, Idaho, carried on during the 1937 field season by the U. S. Geological Survey in cooperation with the Idaho Bureau of Mines and Geology. Although the original plan was to confine the study and geologic mapping to the known areas of mineralization, the deposits proved to be so widely scattered that it was necessary to cover the entire county, particularly in order to solve some of the major stratigraphic, structural, and igneous problems which had a direct bearing on the distribution, kind, and origin of the mineral deposits. To permit mapping of the larger area in the one field season allotted to the study, reconnaissance methods had to be used, and only the broader stratigraphic units distinguished. Detailed methods, however, were followed in the study of the mineral deposits, and sufficient data were assembled to decipher the major features of both geology and mineralization.

In addition to supplying the details on the distribution, occurrence, and structural and mineralogic relations of the ore deposits, and on the kinds and relations of rock masses, the study has also contributed a great deal to the knowledge of regional geologic problems, particularly to those dealing with the relation between mineralization, igneous activity, and structural geology in northern Idaho. It has supplied the necessary information to fill in a broad gap in the geologic map of the state; has extended the mapping of the Belt series, and permitted recognition of regional variations in its formations; and has made it possible to distinguish three unrelated epochs of igneous activity during which magmas were intruded as sills, batholiths, stocks, and dikes. With the earliest activity (late pre-Cambrian) is associated the intrusion of sills of the Purcell type into the lower member of the Belt series, the Priohard formation; the Jurassic or Cretaceous period, the emplacement of huge batholithic masses (the Nelson) in part by granitization of the invaded Belt strata; and in the early Tertiary (?), the injection of dikes along the core of a broad, anticlinal uplift. The most important contribution, however, is recognition that the mineralization is probably related to the igneous activity associated with the broad, anticlinal uplift, and that the major faults of the region, such as the famous Geburn and Placer Creek, and others of the same kind and order of magnitude, previously unreported, are associated with collapse of the broad uplift and are, therefore, not faults of large, horizontal displacement as heretofore considered.

FIELD WORK AND ACKNOWLEDGMENTS

The field work was underway on June 20, 1937, and continued without interruption through the first week of September. Serious effort was made to visit each mine and prospect in the county, but a few had not been worked for so many years that their locations had been forgotten and their presence effectively concealed by brush and timber. A few others were missed inadvertently, as reconnaissance mapping did not permit traverse of every ridge and gulley. Topographic maps prepared by the U. S. Geological Survey many years ago were found unsatisfactory as base maps for geologic mapping, and were discarded in favor of recent maps of the Coeur d'Alene National Forest prepared by the U. S. Forest Service. During the early part of the field work, the writer was assisted by Mr. John S. Miller, and for the remainder of the season by Mr. Pal A. Lincoln, both enrolled in the University of Idaho School of Mines.

While in the field, the writer received invaluable aid from many people in the county to whom sincere thanks are given. Special acknowledgment is due Mr. C. L. Dittemore, Secretary of the Coeur d'Alene Chamber of Commerce, for his untiring
efforts in arranging the study of the district; to Mr. C. O. Bowdler, Secretary of the Caribou Mining Company, who spent a day with the writer in the Beauty Bay dis-
trict; to Mr. J. B. Sullivan, Secretary of the Shamrock Silver Mining Company, who extended special courtesies at the Shamrock mine in the Hayden Lake district; and
to Mr. C. W. Williams, who gave of his time and information. To these acknowledg-
ments must be added those due the field assistants who performed their duties most
efficiently.

PREVIOUS GEOLOGIC WORK

No general study of the geology and mineralization of Kootenai County had
previously been attempted, and the only available geologic data were contained in
reports dealing with special problems, or in reports on neighboring counties. Such
older data as are available are contained in the appended list of publications, each
accompanied by a brief abstract of its contents in so far as the information
applies to Kootenai County.

Calkins, F. C., A geological reconnaissance in northern Idaho and northwestern
sketchy geologic map of northern Idaho and has some notes on the
geology of Kootenai County, particularly along the Purcell
Trench.

Survey Bull. 611, pp. 150-156, 160, 1915. Has notes on the
rocks in and bordering the Purcell Trench.

Soper, E. K., The mining districts of northern Idaho: Min. and Sci. Press,
vol. 116, p. 125, 1918. Mentions some of the mineralized areas
in Kootenai County.

and Geol. Bull. 7, 1900. Gives the occurrence and tests on
some clay deposits near Coeur d'Alene City.

Davenport, R. W., Coeur d'Alene Lake, Idaho, and the overflow lands: U. S.
conditions along the Coeur d'Alene River.

Umpleby, J. B., and Jones, E. L., Jr., Geology and ore deposits of Shoshone
Refers to copper mineralization and siderite veins along the
Little North Fork of the Coeur d'Alene River and at the Palisade
in the Fine Creek district.

Thomson, F. A., et al., A preliminary study of certain reported platinum occur-
Pamphlet No. 6, 1926. An investigation of reported platinum
occurrences in Kootenai County, and discloses that the occur-
cences were non-existent.

Bryan, Kirk, and Pardee, J. T., Geology of the Latan formation in relation to
the lavas of the Columbia Plateau near Spokane, Washington:
U. S. Geol. Survey Prof. Paper 140, pp. 1-16, 1926. Describes
the occurrence of fossiliferous lake beds near Coeur d'Alene
City.
Anderson, A. L., Some Miocene and Pleistocene drainage changes in northern Idaho: Idaho Bur. of Mines and Geol. Pamphlet No. 18, 1927. Discusses the glaciation along the Purcell Trench and the origin of the lakes bordering the trench, also drainage changes associated with the outpouring of Columbia River basalt and later with the Pleistocene glaciation.


Gillson, J. L., Granodiorites of the Pend Oreille district, Idaho: Jour. Geol. vol. 35, pp. 1-53, 1927. The petrography and petrology of the granitic rocks at the south end of Pend Oreille Lake, including some of the rock in adjoining parts of Kootenai County.

Sampson, Edward, Geology and silver ore deposits of the Pend Oreille district, Idaho: Idaho Bur. of Min. and Geol. Pamphlet No. 31, 1928. The geology of a part of Kootenai County surrounding Pend Oreille Lake.

Gillson, J. L., Contact metamorphism of the rocks in the Pend Oreille district, northern Idaho: U. S. Geol. Survey Prof. Paper 136-f, 1929. The study includes some of the rocks in Kootenai County adjacent to the granitic rocks near the south end of Pend Oreille Lake.


Tullis, E. L., and Laney, F. B., Composition and origin of certain commercial clays of northern Idaho: Econ. Geol., vol. 26, pp. 466-496, 1933. Mentions the clay deposits near Coeur d'Alene City.

GEOGRAPHY

LOCATION

Kootenai County is in the northern part of Idaho (fig. 1), and is bordered on the west by the Washington state line, on the east by Shoshone County (which contains the famous Coeur d'Alene mining district), on the north by Bonner County, and on the south by Benewah County. Its shape is approximately rectangular and its maximum length north and south is 42 miles; its width east and west about 34 miles. The area included within its borders totals 1,253 square miles.

SURFACE FEATURES

Relief

Much of the county is mountainous and is contained in the Northern Rocky Mountain physiographic province, but a part covers an embayment of the Columbia plateau. The mountainous part is composed of two well-defined groups, the Selkirks and the Coeur d'Alenes, separated by a broad, intermontane depression, the Purcell Trench, which extends southward from Canada. The mountains are the kind commonly characterized as dissected uplands (plate 1,A).

The Selkirks are the more imposing of the two mountain groups and lie along th-
Figure 1. INDEX MAP OF IDAHO, SHOWING LOCATION OF KOOTENAI COUNTY.
middle western and northwestern border of the county, spreading westward over a much larger area in Washington. These mountains belong to one of the major systems in Washington, Idaho, and British Columbia, and extend from Canada to within a few miles of the south border of Kootenai County. Near the mid-part of the county the group is crossed by the Purcell Trench and the south end is, therefore, separated and more or less isolated from the main mass. The detached group is not so high as the remainder and its culminating point, Mica Peak, only rises to 5,260 feet, or about 2,650 feet above the plateau surface. To the north, the highest point is Mount Spokane at 5,808 feet, which, however, lies several miles west of the state and county line. The south end of the mountains is partly encircled by the Colum- bia Plateau and its border is determined by irregularities of the plateau margin, but, where the mountains lie along the Purcell Trench, their borders are steeper and more regular, and the lower slopes show the effects of glacial scour.

The Coeur d'Alene Mountains form an intricately dissected mass east of the Purcell Trench and east of Coeur d'Alene Lake, which extends southward from the Trench. This group covers more than half the county, and spreads eastward and southward into and across Shoshone County. The mountains appear as a submaturely dissected upland (p.l. 1A) with ridges rising to different levels, the highest of which have been given the names of mountains and peaks. Among these may be mention ed Chilco Mountain at 5,506 feet, Spade Mountain at 5,026 feet, Hamilton Mountain at 5,070 feet, and Huckleberry Mountain at 4,860 feet. Many others at lower levels also have been named. These ridge levels indicate several epochs of accelerated erosion corresponding with as many uplifts. The lowest level outlines a broad, old valley surface, in part gravel-capped. The ridge slopes are in general steep, and the crests are sharp without remnant flats. Only where the mountains border the Purcell Trench do they show evidence of glacial erosion.

The Purcell Trench is an intermontane valley of major magnitude which extends east and north from the plateau margin near Spokane, Washington, across the corner of Kootenai County, and north to where it joins the Rocky Mountain Trench in Canada about 200 miles from the international border. It has a wide, notably flat floor, narrow in proportion to its great length, and bounded by steep mountainous slopes which rise to levels from 5,000 to 7,000 feet above. The trench, a linear feature of unusual length, is extraordinary in that it is largely unoccupied by streams though crossed by many, of which the Kootenai River and the Clark Fork of the Columbia are the largest. Near the Bonner County line, where it is joined by two other valleys of large size, the Hoodoo Valley and Corral Valley, its floor is about 13 miles across. The trench narrows to the south. At Rathdrum, it is 8 miles wide, and at the state line about 4 miles. The floor of the trench has a gradual slope to the south and west, from an altitude of 2,400 feet at Athol to 2,100 feet at the Washington line. It has no surface drainage, except the Spokane River which flows along its south margin west from Coeur d'Alene. Some low morainal hillocks occupy its floor near the north margin of the county; but much of the floor has the appearance of a somewhat channelled outwash plain, its nearly level surface rising above the bottoms of tributary valleys. It has one island-like mountain, Lone Mountain, rising 800 feet above its surface near the west side of the trench, 3 miles from the base of the Selkirk Mountains.

The Columbia Plateau forms a deep embayment in the southwestern part of the county. It extends around the south end of the Selkirk Mountains and spreads eastward and southward against the Coeur d'Alene Mountains and its outliers. Its surface is coextensive with the floors of Columbia River basalt. East of Coeur d'Alene Lake and along the Coeur d'Alene River, the surface of the plateau has been largely destroyed by erosion, or is retained as broad, basaltic terraces on the lower flank of the mountains. West of the lake to the state line, the surface has been little dissected so that it preserves its plateau character. Most of the plateau surface has an altitude of about 2,600 feet, but in places it appears to be slightly tilted and is carried to levels of 2,700 feet.
A. Coeur d'Alene Mountains drained by the Little North Fork of the Coeur d'Alene River.

Shows the general accordance of ridge levels and its origin by dissection. Typical forest vegetation.

B. Beauty Bay.

Illustrates the irregular shoreline of Coeur d'Alene Lake and its origin as a drowned stream or river valley. Beauty Bay mining district is located nearby.
Drainage

The Selkirk Mountains are drained locally by streams of minor size, all of which, except Mica and Rock creeks of the Mica Peak group, fail to enter major streams. Instead, they disappear in the gravels along the western margin of the Purcell Trench. The Coeur d'Alene Mountains are mostly drained by the Coeur d'Alene River, and by one of its major tributaries, the Little North Fork, which reaches far north toward the Bonner County line. The Coeur d'Alene River flows in a westerly direction into Coeur d'Alene Lake, about midway between the inlet and outlet. The lake is drained by the Spokane River. Before crossing the state line, the Spokane River tumbles across a ridge at the margin of the Purcell Trench at Post Falls, forming a waterfall of the same name as the town. Some of the drainage along the south border of the county is into the St. Joe River, which feeds the head of Coeur d'Alene Lake; Hayden Creek and its tributaries is marginal to the Purcell Trench. Both the Coeur d'Alene and St. Joe rivers have prominent graded flood plains, their present floors lying a hundred feet or more above bedrock. Their channels are set within natural leveses.

Lakes

Kootenai County is more famous for its lakes than for its streams and rivers, and contains a number of them in the valleys bordering the Purcell Trench and the Coeur d'Alene and St. Joe rivers. Those which border the Trench are in valleys which extend back into the mountains; Hauser, Twin, and Spirit lakes into the Selkirks; Hayden and Fernan lakes into the Coeur d'Alene Mountains; and Coeur d'Alene Lake southward between the two groups and for some distance along the edge of the Coeur d'Alene Mountains and the Columbia Plateau. These lakes are in valleys dammed by the glacial outwash which has built up the floor of the Purcell Trench to its present high level. Only Coeur d'Alene and Fernan lakes have surface outlets, the others drain through the gravels of the trench. The shore of Coeur d'Alene Lake follows the 2,124-foot contour and the water of the lake extends up many tributary valleys. The lake, therefore, has a very irregular shore line indexed by numerous bays, of which Wolf Lodge Bay is the largest and best known. Beauty Bay is tributary to Wolf Lodge Bay (p1. 1B). Much of the lake has a width of about 2 miles. The other lakes are considerably smaller, but Hayden Lake is as famous for its scenic beauty as is Coeur d'Alene Lake.

The lakes which border the Coeur d'Alene and St. Joe rivers are much smaller than those which lie against the Purcell Trench. Thompson, Blue, Swan, Cave, Black, Anderson, Killarney, Medicine, and Rose lakes are along the Coeur d'Alene River, separated from it by natural levees and occupying parts of the valley and of tributary valleys which had not been filled by deposits and raised to the present river level. Chatcolet, Hidden, Round, and Benewah lakes are in the St. Joe Valley, although Chatcolet Lake is actually a part of Coeur d'Alene Lake cut off from the main body of water by a delta distributary of the St. Joe River.

Pond Oiseille Lake barely extends into the north end of the county. This lake, which is the largest and deepest in north Idaho, is about 42 miles long, and as much as 1,100 feet deep. Occupying a glacial trough, it is bordered for the most part by precipitous slopes but is held in on its south end by a terminal moraine.

CLIMATE AND VEGETATION

As the county is along the western margin of the Northern Rocky Mountains, its climate is not as rigorous as that east of the Continental Divide. The summers are warm, rarely hot, the winters cool but usually not severely cold. During the summer, the region is cooled by prevailingly west or southwest winds from
the direction of the Pacific Ocean; in winter, the temperature is also more or less tempered by winds from the same direction. Only during the occasional movement of a polar air mass across the region does the county experience severe winter cold. The precipitation is mostly concentrated in the autumn, winter, and spring months, reaching a maximum from January to March. Rain is generally negligible during the summer, but summer droughts are not infrequently broken by rains and thundershowers of brief duration. The precipitation ranges from about 20 inches annually in the southwestern part of the county to as much as 40 inches in the mountains along the eastern margin. Much of the precipitation in the higher slopes occurs as snow, which commonly accumulates to depths of six feet or more. In the Purcell Trench, the depth of snow generally does not exceed three feet.

The vegetation reflects the fairly abundant precipitation. The entire county was formerly heavily timbered and is now partly covered by stands of virgin timber and by dense growths of brush and second growth, except where the land has been cleared for cultivation. The timber growth comprises mixed conifers, yellow pine dominating along the drier western margin of the county, white pine over most of the remainder. These stands are admixed with cedars on protected north slopes and along stream bottoms, and also with larch, hemlock, spruce, fir, and other variations. White pine has been the principal tree crop. Precipitation is ample to permit heavy brush and tree growth on the south as well as on the protected north slopes. No parts of the county are high enough to stand above timber line.

**POPULATION AND INDUSTRIES**

Kootenai County has a total population of 19,469, nearly half of which is contained in Coeur d'Alene City, the county seat. The rural population is not large, and much of the remainder is scattered through smaller towns and settlements; namely, Post Falls, Rathdrum, Spirit Lake, and Athol, in the Purcell Trench; Harrison, on Lake Coeur d'Alene near the mouth of the Coeur d'Alene River; Cataldo, Rose Lake, Medimont, and Lame, along the Coeur d'Alene River; and Worley, on the plateau in the southwest part of the county.

Lumbering is the principal industry, and all settlements are or have been largely dependent on this single industry. Most of the towns flourished while logging was active, but where local timber supplies have been exhausted population has dwindled considerably. Much of the plateau area has been cleared of timber and brush, and is given over to the raising of wheat. Dairying has also come into prominence particularly along the lake and river flats, and in the Purcell Trench. The flood plain along the Coeur d'Alene River, however, has been so thickly covered with till tailings from the Coeur d'Alene mining district as to be unfit for agriculture. Farming, including dairying and fruit-raising, is important in parts of the Rathdrum Prairie and the Spokane Valley. Because of the gravelly character of the outwash plain, farming is impossible, except by irrigation. Water for part of the area between Hayden Lake and Rathdrum is pumped from Hayden Lake, but this source is inadequate for more than a small part of the Trench. Mining has not been a gainful industry, although much money has been expended locally in prospecting. The reactivation resources for which Kootenai County is famed are important. Coeur d'Alene City is the center of a thriving summer resort and tourist industry, its city park being a much-used picnic ground for people of northern Idaho and eastern Washington.

**ACCESSIBILITY**

Most parts of Kootenai County, except the more remote mountainous areas, are easily accessible. The county has six railroads, boat service on Coeur d'Alene and Pend Oreille lakes, three state highways, and a well-maintained system of county
and forest roads. Coeur d'Alene City is a terminus for branch lines of the Northern Pacific, Great Northern, and Milwaukee railroads. The main lines of the Northern Pacific and Spokane and International rail systems, and a branch line of the Milwaukee, pass up the Purcell Trench. A branch line of the Union Pacific extends across the south-central part of the county from Spokane, Washington, to Wallace, Idaho, along the shore of Coeur d'Alene Lake and thence up the Coeur d'Alene River. The main line of the Chicago, Milwaukee, and St. Paul Railway also crosses the southwest corner of the county. The logging road of the Ohio Match Company extends from the Spokane and International line near Garwood, eastward over the Hayden Creek-Little North Fork divide into the upper drainage of the Little North Fork.

The Yellowstone Trail (U. S. Highway No. 10) crosses the county from east to west. It leaves the valley of the Coeur d'Alene River near Cataldo at the Shoshone County line and crosses the Fourth of July summit to descend to Coeur d'Alene Lake. It skirts Wolf Lodge Bay and passes through Coeur d'Alene City westward to the Washington line. The highway is paved with concrete between Coeur d'Alene and Spokane, and for several miles east of Coeur d'Alene; the remainder is oiled. The North and South Highway (U. S. Highway No. 95) crosses the county from north to south. The east branch lies along the east side of Coeur d'Alene Lake, from Harrison to its junction with No. 10 at Wolf Lodge Bay. The west branch passes through Worley and extends northward across the plateau area and through low passes on the lower slopes of the Selkirks to the head of Coeur d'Alene Lake at Coeur d'Alene City. The combined branches continue northward up the Purcell Trench into Bonner County. The mountainous area in the east half of the county is fairly accessible as it contains a net of roads along valley bottoms and ridges mostly built since 1932 by the Civilian Conservation Corps in cooperation with the U. S. Forest Service. On them it is possible to reach any part of the mountainous region during the open season.

GEOLOGY

FOREWORD

Kootenai County is underlain by a heterogeneous assemblage of sedimentary, igneous, and metamorphic rocks. It has many of the stratigraphic and structural features of Shoshone County, but igneous rocks are much more widely distributed and include some varieties not present in the neighboring county. The sedimentary strata comprise the oldest and the youngest of the rocks; the igneous rocks include intrusive sills, dikes, stocks, and batholiths, and flows of Columbia River basalt. The metamorphic rocks are closely associated with the batholithic rocks and are clearly a phase of igneous intrusion.

The relations of the rock masses are complex and reflect widespread crustal disturbances involving both folding and large-and-small-scale faulting. Only the older sedimentary strata have been affected by the structural disturbances, and they are the only rocks cut by the igneous intrusives.

SEDIMENTARY ROCKS

Summary Statement

The sedimentary rocks are represented by the Belt series (pre-Cambrian) by small remnants of Cambrian strata, by beds of the Lateh formation (Miocene) and by unconformable late Tertiary and Quaternary deposits. The Belt series is of greatest interest as it is the host for all the known mineral deposits in the county.1

The other sediments, except the Cambrian strata, are younger than the mineral deposits, but afford much of general interest.

**Belt Series (pre-Cambrian)**

The members of the Belt series comprise the prevailing rock of the Coeur d'Alene Mountains, and, therefore, underlie fully half the county (pl. 2). Its members are much like those in Shoshone County and may be identified as the Frichard, Burke, Revett, St. Regis, Wallace, and Striped Peak formations. It was not possible to map each of these separately in the time available for study. The formations are in part somewhat thicker than corresponding units in the Coeur d'Alene district and differ in minor degree in some of the stratigraphic characters. The differences, however, are not too marked to prevent correlation.

The Belt series in general is composed of well-stratified sandstones, quartzites, shales, argillites, and impure limestones, the limestones predominating in the middle of the section, the argillites in the upper part. The members abound with ripple marks and sun cracks, and afford ample evidence of shallow-water deposition. Colors range through shades of grey, green, red, purple, buff, white, and locally black. No measurements of thickness were made, but the series locally is not less than 25,000 feet thick and may be considerably more. The subdivision into formations is more or less a matter of convenience, as there are few sharp boundaries between formations throughout the series.

**Frichard formation**

The Frichard, the lowest formation of the Belt series in Kootenai County, is the most widely distributed and underlies nearly a fourth of the county. It forms a broad belt which extends continuously from Coeur d'Alene City to the Shoshone County line, and spreads southward into Bonneville County (pl. 2). It is in large part separated from other formations by fault contacts, but on the north its dip carries it beneath the overlying Burke formation. As mapped, it may include some small scattered masses of the Burke formation.

The formation is composed largely of bluish shale and argillaceous sandstone with subordinate beds of grayish sandstone and white quartzite. The upper part in particular is thinly laminated, and its laminae are colored various shades of bluish-gray. In the vicinity of large faults, the shale generally has prominent slaty cleavage and may locally be classed as slate rather than as shale. In some places, the formation appears to contain a white or gray quartzite member, probably not less than 300 or 600 feet thick, which in many respects resembles the younger Revett quartzite. Such a quartzite member is exposed for some distance along Marie Creek and crops out in a few other places. It appears well toward the top of the formation; the beds both above and below consist largely of the laminated, thinly bedded shale with some interposed thin beds of sandstone and quartzite. Toward the lower part, the Frichard appears to become more quartzitic and to contain less of the shaly beds, but those lower quartzite beds are in general distinctly argillaceous. Because of faulting and the many consequent repetitions of beds, the thickness of the exposed Frichard can not be satisfactorily measured, but it probably exceeds 5,000 feet, the thickness measured in Shoshone County.

Weathered exposures of formation all have a dark, rusty appearance, largely because of the oxidation of fairly abundant pyrite in the shaly beds. This feature, together with the bluish-gray appearance of its thinly laminated, unweathered shales, helps to distinguish the Frichard from other formations. The Frichard formation also has a tendency to be cut by deep, narrow valleys and gulches separated by sharp ridges; and to form prominent ledges, unlike the other members.
of the Belt series, all of which have very poor outcrops. Its distribution can in general be read satisfactorily from its expression in the topography and from the relative abundance of good bedrock exposures.

Burke formation

The Burke formation is less widely distributed than the Frichard, mostly because of its lesser thickness. In mapping, it was not differentiated from the Revett and St. Regis, and its distribution nearly accords with that shown for all three (pl. 2). It is widely distributed south of the Coeur d'Alene River in the southeast corner of the county, also in the hills that rise above the plateau surface on both sides of Coeur d'Alene Lake. It appears on Mount Coeur d'Alene and toward the lake on the southwest. The best exposures of the Burke formation, however, are in the recent road cuts along Ferman Creek, on Copper Mountain, and in some of the valleys between. It also appears in the canyon of the Little North Fork above the Breakwater, and on Monument Peak. The only isolated exposure aside from those in the southwestern part of the county is on Chilco Mountain. Its outcrops mainly border those of the Frichard or lie alongside the Frichard because of faulting.

The Burke formation shows noteworthy changes in character in different parts of the county. Along upper Ferman Creek, it is not much different from the Frichard, but its shales are more siliceous and not so finely laminated. Much of it, therefore, may be classed as argillite with thin beds of fine-grained massive sandstone and sericitic flaggy quartzite. Much of the rock is pale tinted and has a pale greenish cast. It has considerably less pyrite than the Frichard and, consequently, the rock weather to a light, clear gray. Its characters are similar on Copper Mountain, but in one place it appears to have a purplish banded grayish bed, such as characterizes the St. Regis formation. In the north part of the county, it appears to be much more siliceous and to be made up of a greater proportion of massive sandstone with less argillite. In the south part of the county, however, it is much more quartzitic and markedly resembles the overlying Revett. In places, it cannot be distinguished from the Revett with certainty. It contains an abundance of ripple marks and sun cracks, which may aid in distinguishing it from the Frichard formation.

The Burke and Revett tend to resist erosion and form the higher ridges and peaks. Thickness measurements were not made, but the thickness of the formation appears to be variable and may range between 1,000 and 3,000 feet. It is probably thickest where it is most quartzitic, as in the southeastern part of the county.

Revett quartzite

The Revett quartzite has the same general distribution as the Burke and in most places detailed study is needed to separate it from the Burke. Its best exposures are near Harrison, in the Latour Creek drainage south of the Coeur d'Alene River, and in the hills east and south of Worley (see pl. 2). It appears to lose its identity in the northern part of the county where its beds are more argillaceous and closely resemble the Burke.

The Revett is somewhat similar to the Burke, but, except in the northern part of the county, its beds are more massive and are composed largely of white and gray sericitic quartzite with only minor amounts of interbedded argillite. The rock weathers white, and its color, together with its massive structure, helps to establish its identity, but does not serve to distinguish it from the more quartzitic beds of the Burke south of the Coeur d'Alene River. Like the Burke, the Revett tends to accentuate ridge tops and on the higher ridges may be traced by bands of
white, quartzitic talus. Its thickness is apparently variable, but may approach 3,000 feet in the southern part of the county.

**St. Regis formation**

The St. Regis formation is more widely distributed in the northeastern part of the county than either the Burke or the Revett, but is absent in the southern part, apparently because of erosion. Its main occurrences are along Skitwish and Huckleberry peaks and the region between, and for some distance to the north. It also forms a strip extending north and northeast from Leiberg Creek over Lookout Ridge and Hamilton Mountain, the latter being in the extreme northeastern corner of the county. Other exposures appear along the Little North Fork above Honeysuckle Ranger Station, and on Budlow Mountain near the north end of Hayden Lake.

The St. Regis formation is more distinctive than the others for it is characterized throughout by reddish beds and can be confused only with the younger Striped Peak formation. The lower part is quartzitic and is not much unlike the upper part of the Revett, but the beds contain members with purplish markings and are further associated with scattered thin beds of reddish and purplish argillite, interbedded with greenish shale and argillite. In places, the quartzites have only a faint pinkish cast, but even in such beds thin partings of reddish shale are common. The upper part is less quartzitic and consists mostly of alternating red and green shales and argillites, green argillite becoming increasingly abundant at and near the top. The formation in the eastern part of the county is perhaps no more than 1,000 to 2,000 feet thick, and consists largely of greenish and purplish quartzite and shale, but its thickness increases markedly westward and beyond Huckleberry Mountain may be at least twice as thick. The formation shows ripple marks and sun cracks throughout.

**Wallace formation**

The Wallace formation is widely distributed through the northeastern part of the county (pl. 2), and has a greater areal distribution than any other formation, except the Prichard. Except for some faulted blocks of Burke and patches of Striped Peak formation, it covers the entire upper drainage of the Little North Fork and extends west to the Purcell Trench. It is especially well developed in the drainage area of Hayden Creek and also has excellent exposures along the Little North Fork, both above and below Honeysuckle Ranger Station. Some beds of Striped Peak may have been mapped with the Wallace formation.

This formation is distinguished from all others by the abundance of calcareous members, and, unlike any other formation except the Prichard, shows little stratigraphic variation throughout the county. The lower part of the formation is much like the upper part of the St. Regis, and is made up largely of greenish argillites but with scattered, thin beds containing calcium carbonate. Toward the middle of the formation the amount of calcareous material greatly increases, and beds of calcareous sandstone and quartzite and of impure limestone become conspicuous. In the upper part of the formation, the amount of calcareous material decreases somewhat, and the prevailing beds are mostly of a dark gray and bluish gray shale and argillite, which might be easily confused with the shaly beds of the Prichard, were limy members absent.

The Wallace is probably not less than 5,000 feet thick and its recognition is based largely on the abundance of calcium carbonate. The weathered rock is likely to show a cellular structure produced by the leaching of the carbonate, and this feature may even be recognized in small fragments in the soil where outcrops are not exposed. In addition, the beds tend to weather rather deeply to a
buff or faun color which is also distinctive. The most diagnostic beds are the
dark gray ones near the top, particularly as they are especially susceptible to
acellular weathering.

Striped Peak formation

The Striped Peak formation is also widely distributed in the northeastern part
of the county, although it is not as widespread as the Wallace (pl. 2). Excellent
exposures are afforded on Colt Mountain and for a short distance along the Little
North Fork above and below. It is also well exposed along the northeast border of
the county and on Cedar Mountain adjacent to the Purcell "ranch. Other exposures
are south and west of South Chilco Mountain.

The Striped Peak is probably the most heterogeneous of the lot. Along the
eastern margin of the county, and as for west as Colt Mountain, it is very similar
to the St. Regis, being largely made up of purplish-and reddish-colored quartzites
and sandy beds with interspersed reddish and greenish beds of argillite. Westward
and to the north the reddish and purplish markings disappear and the formation is
composed largely of sandstone or quartzite, having more or less of an olive-green
color. As a whole, the formation is more quartzitic than the Wallace, although no
more quartzitic than the St. Regis. It has in addition some dark green shaly beds,
and also thinly laminated shales made up of thin, alternating, dark gray to black
and yellow bands, many of them to the inch. It also has some calcareous members
in the lower part, and where the reddish beds are missing it is difficult, or im-
possible, to distinguish the formation from the Wallace. The Striped Peak appears
to be thick, and locally may measure more than 4,000 feet.

Cambrian System

Rocks of Cambrian age are confined to the vicinity of Pond Oreille Lake, and
are most widely exposed on the east side of the lake in Bonner County near Lake-
view; but some beds are also exposed at Bayview on the west side of the lake (pl.
2). These rocks have been divided by Sampson into three formations; the Gold
Creek quartzite, the Ronice shale, and the Lakeview limestone, but the Lakeview
limestone is the only one exposed at Bayview.

Lakeview limestone

The limestone at Bayview is in contact with intrusive granodiorite and has
been metamorphosed to a coarsely crystalline marble. Some of the marble was de-
rived from a fairly pure limestone, but a part of it is dolomite. The pure marble
has been quarried and burned to lime. Near Lakeview, where the beds are less in-
tensely metamorphosed, they are fossiliferous and contain a trilobite fauna recog-
nized as Middle Cambrian.

Tertiary System

Two series of sediments are assigned to the Tertiary. One constitutes the
Latah formation of Miocene age; the other, stream gravels that are probably some-
what younger. As the Latah formation is exposed only in road cuts and is every-
where capped by other rock, it can not be shown on the geologic map. The younger
gravels are widespread on lower ridges bordering the main streams, but only those
patches that effectively conceal the bedrock below have been mapped (pl. 2).

\[\text{Sampson, Edward, "Geology and silver ore deposits of the Pond Oreille district,
Idaho"; Idaho Bur. Mines and Geology, Pamphlet No. 31, pp. 9-10, 1928.}
\]

\[\text{Idem, p. 10.}
\]
The Latah formation is apparently coextensive with the flows of Columbia River basalt and underlies the plateau areas and remnants of basalt terraces. One exposure was observed in a highway cut at Harrison, and others are known to occur at other places beneath capping flows of basalt. The actual distribution of the formation can be determined only by drilling through the lava flows. The formation is probably thickest and most fully developed beneath the basalt that lies north of Coeur d'Alene City between Hayden Lake and the gravel-covered floor of the Pureell Trench. Examination of a deep well log by the writer a few years ago shows that as much as a thousand feet of these beds underlie the basalt and rest upon a floor of granitic rock.

The formation consists largely of well stratified conglomerates of alternate layers of cobbles and sand of vary size with a Miocene leaf flora. / Some of its beds contain a Miocene leaf flora. / Because of inadequate exposures, the formation can not be satisfactorily studied. Some of its cobbles might be used commercially.

**Gravels**

The late Tertiary (?) stream gravels are mostly exposed on the lower ridges bordering the Coeur d'Alene River and its main tributaries, but some patches have been mapped on a few of the lower, flatter ridges along Farnam Creek and on the flat ridge between Wolf Lodge Creek and Blue Creek (pl. 2). These gravels, only the largest bodies of which have been mapped, occupy remnants of old valley surfaces that existed during the Tertiary and have since been incised by the present streams. In places, these deposits have been partly washed from the ridges onto the slopes below and tend to conceal much of the bedrock beneath. There are also other deposits along the Coeur d'Alene River, particularly between Cataldo and Rose Lake and between Medimont and Lane, which may represent somewhat younger accumulations at lower levels. Those deposits are from 50 to 100 feet above the present water surface and several hundred feet below the older gravel caps. The origin of these younger deposits is not yet understood.

The gravels are largely the product of erosion of the Belt series, but contain some admixed igneous rocks. Most of the cobbles are derived from the more resistant quartzite formations, although some of the larger ones are of weaker argillites which have not been transported for any great distance. The cobbles are generally well rounded and show evidence of having been water-worn.

The age of these gravels is somewhat uncertain, but their deposition was probably brought about by a change in the stream gradient caused by the damming action of the Miocene basalt flows in the lower drainage courses. This is suggested because the old valley surfaces and the plateau surface closely accord in altitude near their junctions, and because between Wolf Lodge Creek and Blue Creek the gravels spread locally over the basalt surface itself. Erosion since has extended to about the same depth in the old valley surface as it has in the basaltic plateau.

**Quaternary System**

The Quaternary deposits are represented by glacial deposits of Pleistocene age and by Recent stream alluvium. The glacial deposits are the products of two advances of the ice, the earlier called by Brotz / the Spokane advance, the later


called the Wisconsin advance. These two glacial advances were apparently separated by an erosional interval.

Pre-Wisconsin deposits

The deposits assigned to the earlier glaciation are mostly confined to the margins of the Puget Trench, although there are remnant islands on the floor of the trench itself (pl. 2). There are also ice-rafted boulders and debris far back in the mountain valleys, left on the floor and along the shores of glacial lakes at altitudes of as much as 2,600 feet. Deposits within and along the sides of the trench, however, are the only ones large enough to show on the map. These comprise terraces on both sides of the Spokane Valley, which act as dams across the mouths of tributary valleys, as deposits on the flanking slopes, as an island a short distance northeast of Post Falls, and as broad terraces that extend diagonally across the trench from Spirit Lake to Athol, and from Twin Lakes to Lone Mountain. A thick accumulation also lies on the low hills between Hayden Lake and the Puget Trench (pl. 2).

A part of the deposits consists of outwash, a part, of glacial till. The terraces flanking the trench are composed of well-stratified sand and gravel, commonly with forests dipping into the reentrant valleys; but the slope deposits are usually poorly assorted and may consist largely of till. The terraces present steeply cut fronts to the trench and stand as much as 100 feet above the main valley floor. In general, the terraces have smooth or flat summits, except where cut by gullies. The broad terrace between Spirit Lake and Athol, however, has an irregular, hummocky surface, and may be partly a recessional moraine and partly a pitted outwash plain. The deposits near Hayden Lake are composed of poorly assorted materials and commonly show large boulder erraticos. These deposits may exceed 100 feet in thickness and may represent a part of a lateral moraine. Ice-rafted erraticos of small to large size, and other clumps of the rafted debris, may be found scattered more or less indiscriminately along the slopes facing Coeur d'Alene Lake and on the slopes of all tributary valleys from the present water level to about the 2600-foot contour.

Wisconsin deposits

The deposits assigned to the Wisconsin advances are confined entirely to the Puget Trench (pl. 2) and consist of a terminal moraine at the southern end of Pend Oreille Lake and an outwash plain extending southwestward to Spokane, Washington, trenching in the earlier outwash plain. Apparently the pre-Wisconsin outwash plain was considerably eroded before the Wisconsin advance. The Wisconsin outwash has raised the floor of the trench, but not to the level attained by the pre-Wisconsin outwash. Its deposits are those of an overloaded, advancing stream, the channel of which has shifted from one side of the trench to the other, in part undercutting and eroding the marginal banks of earlier outwash. Like the earlier, it has built up the floor of the trench to a level above that of marginal tributary valleys. The character of the later deposits is not unlike that of the earlier state, and there is probably no great age difference between them.

Recent deposits

Recent deposits are confined to the flood plains of the present streams and extend from the lakes for variable distances upstream (pl. 2). The largest strip is along the Coeur d'Alene River where the flood plain is from one to two miles wide. Other streams have flood plains in proportion to their size. The accumulation is abnormally thick on the lower stream courses because the lake waters have raised the local base level 100 to 150 feet above the former valley bottoms.
The only stream not materially aggraded is the Little North Fork, but it has strips of alluvium of variable width throughout the greater part of its length. In places, the flood plain is absent; in other places, its width increases very markedly, the changes apparently occurring with changes in geologic structure.

Materials composing these deposits have been derived mainly from the erosion of Belt sedimentary rocks and contain only a small proportion of sand and gravel from eroded igneous rocks. The finest materials are along the lower courses of the streams and rivers, particularly in the deltas and the flood plain deposits immediately above. Traced upstream, the deposits become gravelly and bouldery.

**IGNEOUS ROCKS**

**Foreword**

The igneous rocks of the county are apparently related to four separate periods of igneous activity; the earliest to late pre-Cambrian activity, the second to late Mesozoic, the third to early Tertiary (?), and the fourth to mid-Tertiary. Sills (Purcell) were intruded during the first period; batholiths, the second; dikes, the third; and flows of Columbia River basalt were extruded during the fourth.

**Pre-Cambrian Intrusive Rocks**

The pre-Cambrian intrusives have been injected along the bedding planes of the Prichard formation, and have the same attitude as the enclosing strata. It is not certain whether more than one sill is present or whether the different exposures are faulted segments of a single intrusive sheet. The sills are exposed in the central part of the county between Wolf Lodge Bay and the mouth of the Fourth of July Canyon on both sides of the Fourth of July Summit, and also on the slope above the mouth of Beauty Creek (pl. 2). These bodies are from 100 to 800 feet thick and may be traced along the strike of the enclosing strata for long distances. Their rock shows no appreciable variation in composition and may be classed as hornblende-quartz diorite of a rather distinctive petrographic type. Remnants of a similar rock were observed in thick bands of dark-colored hornblende gneiss on the slope of Mission Peak west of Coeur d'Alene Lake. These bodies of gneiss may have been sills of the same kind transformed to gneiss during the intrusion of the Mesozoic batholiths.

The hornblende-quartz diorite is a dark greenish-gray, granular, medium-grained rock of which the grains, except at margins, measure about 3 millimeters across. Dull greenish-black hornblende crystals may be easily distinguished, but the light minerals appear as ill-defined-grayish granules. The leading minerals are hornblende, plagioclase feldspar, and quartz, the proportion ranging from 50 to 60 per cent hornblende, 20 to 30 per cent plagioclase, and 10 to 15 per cent quartz. The lesser minerals include biotite (2 to 4 per cent), magnetite (5 per cent), considerable apatite, scant amount of orthoclase and zircon, and the secondary minerals, actinolite, epidote, zoisite, chlorite, and calcite. The hornblende possesses a distinctive pleochroism, X = pale brown, Y = deep green, and Z = blue, a pleochroism not found in the hornblende in any other rock in the county, and apparently peculiar to the hornblende of the Purcell sills. The outlines of the hornblende are ragged, and the grains are usually bordered by a fringe of actinolitic needles of lighter color but of the same optical orientation. The plagioclase grains are peculiar in that they are literally filled with needles of actinolite, hornblende, and apatite, and hold small irregular grains of biotite and lesser ones of epidote, zircon, and magnetite. Where these inclusions are especially abundant, the twinning in the plagioclase is not visible; otherwise,
the grains have an index above balsam but below quarts, and show the zoning and twinning of a sodic andesine. The contained actinolitic hornblende needles are identical to those fringing the hornblende grains. The apatite needles may penetrate more than one plagioclase or hornblende grain, and the magnetite is scattered in large clusters resembling skeleton crystals which penetrate in and through other minerals. The quartz occurs as irregular anhedral, which embody unevenly into the plagioclase grains. The texture of the rock is granitic rather than diabasic; but the relations of the actinolite, apatite, and other minerals in the plagioclase and hornblende grains suggest that the original rock has been strikingly endomorphosed since its consolidation and that the actinolite and other minerals are later additions to the solid rock.

These sills have partaken of all the crustal disturbances that have affected the Belt series, and their structural and mineralogical relations are the same as those of the Purcell sills in other parts of northern Idaho and in British Columbia. On the basis of their structural and stratigraphic relation and their petrographic characteristics, they are correlated with the Purcell sills, therefore like them, are assigned to a late pre-Cambrian age.

**Mesozoic Intrusive Rocks**

The Mesozoic intrusive rocks are most widespread in the western half of the county and form the whole of the Selkirk Mountains, including the group west of Coeur d'Alene Lake, and also smaller bodies near the south end of Pend Oreille Lake and in and around Hayden Lake (p. 2). The Hayden Lake body has the dimensions of a large stock, but the others are parts of extensive batholiths. Both the masses near Hayden and Pend Oreille lakes are composed of granodiorite, but the rock of the Selkirk is made up largely of gneissoid granite and quartz diorite. Because of the heterogeneous composition of the Selkirk body, it is described separately from the others. The petrographic characters of all are such, however, as to indicate a common magmatic source. These rocks are intrusive into folded and faulted Belt and Cambrian strata, and are continuous northward with the Nelson batholith, the intrusion of which has been assigned to the late Jurassic or early Cretaceous.

**Gneissic complex of the Selkirk Mountains**

The rocks comprising the Selkirk Mountains are mostly banded gneisses, but there are some bodies of massive igneous rock and some of quartzite. The foliation is generally prominent throughout the body, becoming faint only in the rock that shades into massive igneous rock. The gneiss greatly resembles igneous rock, although it may retain sedimentary structures and grade into quartzite.

Most of the gneiss is light-colored, but some is dark and occurs as bands in places several hundred feet thick which alternate with even thicker bands of the lighter-colored rock. The line of demarcation between light and dark gneiss is generally sharp. The gneissic complex was not studied in detail, but the following rock types were recognized: Granite gneiss, quartz monzonite gneiss, hornblende (quartz diorite) gneiss, quartz monzonite, and pegmatite. Other varieties

of lesser distribution were also identified, among them quartz diorite gneiss and sillimanite schist and gneiss. The heterogeneous character of the body and the presence of relict sedimentary structures in otherwise foliated igneous rock suggest a complicated mode of origin.

Granite gneiss

Granite gneiss is apparently the most widely distributed of the gneisses, particularly in the mountains west of Coeur d'Alene Lake. Most of it is strongly foliated and occurs either as lenticular gneiss or as regularly banded gneiss. It is much like granite in appearance and some of it is slightly porphyritic. Its color is light to medium gray and its grains range from 2 to 4 millimeters in diameter. Minerals visible to the unaided eye are biotite, feldspar, quartz, and sphene. The grains of biotite are aligned along the plane of the foliation; others have no definite orientation. In thin section, the aligned biotite grains are neither bent nor broken, and the other minerals show no evidence of granulation or other cataclastic effects. The biotite constitutes from 5 to 10 per cent of the rock, the quartz about 30 per cent, and the feldspars about 60 to 70 per cent. The feldspars include orthoclase, less commonly microcline, and unzoned oligoclase; the orthoclase or microcline are two to three times as abundant as the oligoclase. Sphene and allanite are notably abundant accessories as each comprises from 1 to 3 per cent of the rock. There is also much accessory zircon, magnetite, and in places hornblende, and generally more or less sericite, chlorite, and zoisite.

Much of the plagioclase is embayed and cut by orthoclase, or microcline, and quartz. Many of its grains, however, contain small quartz inclusions, remnants of formerly larger quartz grains. The other quartz is in large lobate grains which encase both the potash feldspar and oligoclase crystals. The sphene and allanite grains also penetrate other minerals.

The minerals and their relations are like those in normal granite rock. The absence of crushing phenomena suggests that the gneissic foliation was formed as a result of crystal growth under stress and not by the action of subsequent stress on the consolidated rocks. The oriented quartz grains within so many of the plagioclase crystals suggest incompletely replaced remnants of quartzite. The relation of the potash feldspar and quartz, as well as the sphene and allanite, also suggest replacement of earlier minerals. In broader areal and structural relations, as well as in petrographic details, the granite gneiss suggests that its origin has been by progressive granitization of sedimentary rock, probably quartzite.

Quartz monzonite gneiss

Some bands of quartz monzonite gneiss are intercalated in the granite gneiss west of Coeur d'Alene Lake, but the variety appears to be much more widespread in the Selkirk Mountains west of the Purcell Trench. The rock west of the lake resembles the granite gneiss, but is somewhat darker and contains several per cent hornblende in addition to slightly larger amounts of biotite. The feldspars are about equally divided between oligoclase, slightly more calcic than that in the granite gneiss, and orthoclase. The quartz content shows no change. The accessories are magnetite and zircon, but allanite, sphene, and other minerals are locally less abundant than in the granite gneiss. As the hornblende content increases, the amount of plagioclase likewise appears to increase and at the same time becomes more calcic. By degrees, the rock may pass into granodiorite and quartz diorite gneiss.

The quartz monzonite gneiss in the main part of the Selkirk Mountains is mostly a lenticular, somewhat porphyritic gneiss, locally showing evidence of crushing. Some orthoclase crystals measure as much as 15 millimeters across, although the
average mineral grains are from 3 to 5 millimeters. The biotite grains are mostly
arranged around the oligoclase crystals, although some are in fractures cutting
across the crystals. Hornblende does not appear as an essential part of the quartz
monzonite gneiss as it does west of Coeur d'Alene Lake. Minerals, in addition to
those mentioned above, include abundant zircon, some magnetite and apatite, and a
little epidote and chlorite. Cataclastic structures may be conspicuous where the
rock has been subsequently sheared along fault zones. The quartz monzonite gneiss
shows the same structural relation as the granite gneiss and similar mineral re-
lations.

Quartz diorite gneiss

The quartz diorite gneiss also appears to be fairly widespread in the Selkirk
Mountains west of the Purcell Trench. A specimen collected near the east end of
Spirit Lake as typical of the facies is a grayish greenish rock made up of sheets
of quartz and feldspar of medium-grain but variable thickness, alternating with
thinner sheets or fragments of finer grains of biotite, feldspar, and quartz. From a
distance, the outcrop resembles a banded sediment rather than an igneous rock. It
shows no cataclastic texture in thin section, although the banding is distinct. Its
minerals comprise about 15 per cent biotite, 35 per cent quartz, 60 per cent andes-
sine, minor amounts of zircon, and a little magnetite. The biotite has pale-brown
to reddish-brown pleochroism which differs from the usual pale-brown to dark
brownish-black colors of the granite gneisses. Otherwise, the mineral relations
are the same as in the other gneisses and the rock appears to be a granitized,
banded sediment.

Hornblende (quartz diorite) gneiss

The hornblende (quartz diorite) gneiss appears as thick and thin sill-like
layers in some of the granite gneiss west of Coeur d'Alene Lake, the sills ranging
from a foot or two to several hundred feet thick. This gneiss is dark-colored, fine-
grained in the smaller sheets, medium-grained in the larger, and is composed of 50
to 60 per cent hornblende, little or no biotite, 35 per cent or less of andesine,
and about 10 per cent quartz. Other minerals are much subordinate and include
zircon, magnetite, and epidote, and locally apatite and sphene. The thin
sections show no cataclastic textures and the hornblende is but imperfectly aligned,
although in most of the rock the gneissic structure is prominent in the hand spec-
imen, especially where there is admixed biotite. The hornblende gneiss are irreg-
ular and in part appear to have plagioclase grains impressed against them. Their
color is greenish. Some of the rock also has microscopic inclusions of a finer-
grained igneous rock rich in blue hornblende, sodic plagioclase, biotite, apatite,
and clusters of magnetite grains. These inclusions are more or less rounded and
are surrounded by dense zones of normal hornblendes. The inclusions have the same
composition as the rock composing the Purcell sills, and the relation suggests that
some of the hornblende gneiss has been produced by metamorphism of these older in-
trusives. In some sections, only long apatite needles and skeleton-like magnetite
clusters remain to indicate the character of the replaced rock.

Sillimanite schist and gneiss

Some of the rock of more pronounced sedimentary character near Spirit Lake is
made up of thin layers of sillimanite schist alternating with thicker bands of
gneiss. The gneissic layers are fine-grained, light-colored, and show small grains
of quartz and feldspar and smaller ones still of biotite, in bands an inch or more
thick. Between are thinner layers of light-colored schist. The easiest parting is
on the schist surface. In places, the layers are contorted as in drag folds. In
thin section, the gneissic bands show as aggregates of reddish-brown biotite, quarte,
twinned and inter-twinned plagioclase, scant orthoclase, and magnetite, to-
gether with patches of sillimanite needles. The schistose layers show mostly
19.
sillimanite. Some of the quartz appears as older inclusions in the rock, but much of it is later and shows penetration into other minerals.

The relations of the schist and gneiss suggest an incompletely granitized sedimentary rock, the sillimanite formed previously in the argillaceous layers during the early stages of metamorphism. Later the sillimanite was partly obliterated as granitization advanced. This kind of rock is fairly common in parts of the Selkirk Mountains and is also conspicuous on Lone Mountain in the Purcell Trench.

Quartz monzonite

Rock without gneissic structure was observed near the west end of Spirit Lake. This rock has the composition of quartz monzonite. It is rather fine-grained, the individual grains ranging from 1⁄16 to 1⁄4 inch in diameter. The rock is massive in appearance, grayish in color, and has a liberal sprinkling of small biotite crystals. In thin section, it shows a normal granitic texture, and is composed of about 10 per cent biotite, 25 per cent quartz, 35 per cent orthoclase, and 35 per cent oligoclase. Zircon, magnetite, and scattered sillimanite appear as accessories, and chlorite as a secondary mineral. The oligoclase is zoned and therefore differs from the unzoned plagioclase in the gneissoid rock. The zoning of the plagioclase suggests crystallization from a solution rather than replacement of an earlier material.

Pegmatite

Thin seams of pegmatite parallel and oblique to the foliation are widely scattered throughout the gneissic complex. These seams range from less than an inch to several inches thick and are composed largely of microcline and quartz with lesser amounts of oligoclase and biotite. Both the microcline and quartz grains penetrate irregularly into the adjacent gneissoid rock.

Genesis

The gneisses of the Selkirk Mountains are apparently for the most part granitized sedimentary rocks of dominantly siliceous character with some intercalated pre-Cambrian diabasic and dioritic sills. Near Coeur d'Alene City, the gneisses grade more or less perceptively into the Frichard formation; it therefore appears likely that the invaded rocks throughout belong to the Belt series. Their alteration has presumably been brought about by magmatic solutions or emanations of hydrothermal character, probably soaking ahead in advance of an intruding body of magma. Such progressive granitization of the invaded strata has produced a batholithic body of huge proportions.

Bayview batholith

The Bayview batholith surrounds the southwest tip of Pend Oreille Lake and extends westward along the slopes of the Coeur d'Alene Mountains to the main part of the Purcell Trench near Corbin. It projects deeply into the mountains between North Chilco and South Chilco peaks and some distance down the slope toward the Little North Fork (pl. 2). It underlies the outwash plain southwest of Pend Oreille Lake at least as far west as Athol and spreads northward toward Sandpoint and the batholith in the main Selkirk Mountains. Its prevailing composition is granodiorite.

A specimen collected on Trapper Creek above the Bunker Ranger Station is typical of the main body of a granodiorite and is a grayish, medium-grained, granitoid rock, showing a faint gneissic banding because of an alignment of conspicuous
ous hornblende crystals which measure from 2 to 7 millimeters long. This alignment is believed to indicate that crystallization took place while the magma was flowing. Hornblende, biotite, quartz, feldspar, and scattered yellowish-brown crystals of sphenite are easily distinguished in the hand specimen. The hornblende forms about 10 per cent of the rock, the biotite slightly less than 10 per cent, quartz about 20 per cent, microcline between 10 and 15 per cent, and andesine about 50 per cent. Other minerals are sphenite, allanite, zircon, magnetite, epidote, chlorite, and sericite. Both epidote and sphenite are conspicuous constituents. This granodiorite has been fully described by Gillson in an article entitled "Granodiorites of the Pend Oreille district of northern Idaho", and he points out that the after-effects of the igneous intrusion have modified greatly the rock itself. From mineral relations and distribution, he shows that much of the microcline, the sphenite, zircon, allanite, apatite, epidote, chlorite, and sericite were formed in the rock after its consolidation under the influence of late magnetic emanations. To this, the writer may add that much of the quartz also appears to be a late addition.

Hayden Lake stock

The Hayden Lake stock encircles the lake (pl. 2) and extends westward beneath the flows of Columbia River basalt. The stock has the same general character as the granodiorite in the Bayview batholith, but that near the ranger station on the east shore of the lake is coarser-grained and has a conspicuous sprinkling of biotite instead of hornblende. Its biotite grains are mostly 2 to 3 millimeters in diameter; the other grains, about twice as large. The grains are not aligned and the rock therefore is typically granitoid. Like the rock of the Bayview batholith, it has scattered conspicuous yellowish-brown grains of sphenite. The complete mineral list includes zoned andesine (40 per cent), microcline (18 per cent), quartz (25 per cent), biotite (15 per cent), and extraordinarily large amounts of epidote, chlorite, sphenite, zircon, allanite, zoisite, sericite, and scmt apatite. Some of the epidote grains are as large as the biotite crystals. These minerals show the same relations as those in the granodiorite at Bayview, and most of the lesser minerals have apparently formed in the rock as after-effects of intrusion.

Early Tertiary (?) Intrusive Rocks

Foreword

Intrusive rocks regarded tentatively as early Tertiary are confined to a belt that stretches east-southeast from Coeur d'Alene City well toward the Coeur d'Alene mining district. These are aligned along the core of a broad, extensively faulted anticlinal uplift, considered the major structural feature of Kootenai County (pl. 2). The intrusives are widely but not uniformly distributed along the structural zone, and are most numerous in the Wolf Lodge area, particularly near Beauty Bay. With one exception, the intrusives are all dikes, most of which are too narrow to be shown except on a large-scale geologic map. The exception is a small stock just above the mouth of Beauty Creek. A similar group of dikes occurs along a structural zone near St. Maries, a short distance south of the county line, but only a few dikes of that zone extend into Kootenai County.

The dikes are represented by many different kinds of rocks, among which diabase, diorite, monzonite, rhyolite porphyry, granite porphyry, porphyritic quartz monzonite, and a host of basic dikes ranging from biotite dikes to biotite lamprophyre have been recognized. These appear as a gradational group.

\[ \text{Gillson, J. L., Jour. Geol., vol. 35, pp. 1-31, 1927.} \]
although the basic dikes may be among the earliest as well as among the latest of the intrusives and appear to be successive injections of a deeper-seated parent magma undergoing differentiation. In general, the larger dikes are composed of rhyolite and granite porphyry; the smaller ones of basic rock. The stock is porphyritic quartz monzonite.

These dikes are of typical hypabyssal rock and were apparently intruded much nearer the surface and cooled much more rapidly than the deep-seated Mesozoic stocks and batholiths. None of these dikes was observed in the gneisses and granodiorites in Butte County, but, in the Clark Fork district where the writer has studied a similar dike zone, some of the dikes have invaded the granodiorite batholith and show evidence of as rapid cooling as those in the Wolf Lodge region. As there is little petrographic similarity between the rocks of the batholiths and those of the dike zones, and as the batholiths and dikes are related to or associated with entirely independent structural features, the younger of which are associated with the dike zone, there is probably no genetic relation between the batholithic magmas and the dike magmas. The intrusion of the dikes is probably separated from the emplacement of the Mesozoic batholith by a considerable time interval, and, therefore, may have been intruded in the early Tertiary which was a time of widespread igneous activity in the Rocky Mountain states. The dike rocks are somewhat different petrographically from the Mesozoic porphyries that the writer has studied in Horseshoe Bond 1/2 and Boise Basin 2/3 in southwest Idaho and can not be correlated with them. They, therefore, are probably not so young as this other series of intrusives but belong to the group of early Tertiary age. This concept is in accordance with the writer's findings in other parts of the state, but has not yet been presented in print.

Diabase

Diabase dikes were observed on Red Horse Mountain and in the abandoned Red Horse mine in the gulch below, but the abundance of rock fragments in the soil indicates that the dikes are fairly numerous throughout the Wolf Lodge area. These dikes have been guided by faults in the Prichard formation, and are commonly only 10 to 15 feet thick, although the one near the crest of Red Horse Mountain is not less than 75 feet thick.

The diabase is dark gray, fine-to-medium-grained, and in thin section possesses a typical diabasic texture modified in part by widely scattered patches of micropegmatite. It is composed of about 40 per cent titaniferous augite and about 65 per cent of slightly zoned labradorite. It also has considerable amounts of apatite and magnetite, and minor amounts of hornblende, biotite, orthoclase, quartz, and sericite mica. The apatite occurs in numerous long needles, some of which penetrate several grains of augite and labradorite. The magnetite is in large grains and scattered grain clusters, resembling large skeleton crystals, which, like the apatite, pass through more than one of the adjoining feldspar and augite grains. The hornblende occurs as partial mantles on some of the augite grains, whereas the orthoclase and quartz compose the granophyric intergrowths in the interspaces between augite and labradorite crystals. These intergrowths appear to have been deposited from late residual liquid, a result of crystal fractionation, and show no evidence of a replacement origin.

Hornblende-biotite diorite

Dikes of hornblende-biotite diorite appear to be fairly numerous. Rock for study was collected from a dike exposed underground on the Royal property on Beauty

Creek and from another in a gulch a short distance north of the east end of Ferran Lake. Depending on the size of the dikes, the rock is fine-to-medium-grained. It is otherwise equigranular and its color is gray. Biotite crystals, some of which are as much as 4 millimeters in diameter, are conspicuous although not so abundant as the dull greenish, somewhat smaller, hornblende crystals. The biotite makes up about 15 per cent of the rock; the hornblende about 20 per cent. Zoned andesine crystals predominate and compose about 60 per cent of the rock. The remainder is divided between less than 5 per cent each of orthoclase and quartz, and such additional accessories as zircon, magnetite, and apatite. The texture of the rock is dominantly granular, but there are some scattered patches of micrographic orthoclase and quartz. The biotite has a prominent reddish-brown color, which is characteristic of the biotite in most of the dikes of the region regardless of rock composition. The apatite, as in the diabase, is notably abundant and occurs in the form of long needles. The unweathered rock shows scattered patches of sericitic mica; the weathered rock, considerable chlorite.

Biotite monzonite

A dike of biotite monzonite was observed on the Idaho Chain mine property on Wolf Lodge Creek. This rock has about 20 per cent of dark minerals composed of conspicuous biotite crystals about 1 millimeter in diameter, about equal amounts of oligoclase and orthoclase feldspars, and minor amounts of accessory quartz, magnetite, apatite, and zircon. A few of the biotite crystals are somewhat larger than the feldsparic grains, but most of them are about the same size and the rock is but moderately fine-grained. Its color is gray, but it is essentially more colored than the diorite. Twinned in the feldspars, except Carlsbad, is poorly preserved and the orthoclase and oligoclase are not easily distinguished. The biotite has the reddish tone characteristic of the group. Chlorite, sericite, and calcite are fairly abundant as secondary products.

Granite porphyry

Dikes composed of granite porphyry were observed underground at the Beauty Bay and Royal properties along Beauty Creek. The one in the Royal tunnel invades the body of hornblende-biotite diorite. The rock is inconspicuously porphyritic, except in thin section, but has scattered crystals of quartz, feldspar, and biotite in a light gray, nearly white, fine-grained groundmass. The phenocrysts comprise about 25 per cent of the granite porphyry of which 20 per cent is zoned endesine and the remainder orthoclase, biotite, and quartz. These phenocrysts are corroded and penetrated by the finely granular groundmass of orthoclase and quartz, and by the small scattered crystals of biotite, magnetite, and zircon. The biotite has a distinctly reddish color.

Rhyolite porphyry

Dikes of rhyolite porphyry are fairly numerous and conspicuous along Beauty Creek and extend northward over the summit of the ridge to the mouth of Cedar Creek. Most of them are from 10 to 50 feet thick and from a few hundred feet to half a mile long, but a few are larger and are shown on the map. Although these dikes show transitions to granite porphyry, they have certain characteristics which make their designation as rhyolite porphyry more appropriate, particularly because their groundmasses are aphanitic rather than fine-grained and because their phenocrysts are more conspicuous, although no more abundant, than those in the granite porphyry. Their appearance, therefore, is more like that of rhyolite than of fine-grained granite.

The rhyolite porphyries are conspicuously porphyritic and have from 20 to 30 per cent of phenocrysts embedded in and corroded by light gray aphanitic groundmasses, which are for the most part minutely granophytic. The phenocrysts consist
of grains of quartz, zoned andesine, and biotite, mostly from 1 to 5 millimeters in diameter, and here and there scattered crystals of orthoclase as much as 25 millimeters long. Ordinarily, the orthoclase and biotite phenocrysts comprise each about 5 per cent of the rock; the quartz, 5 to 10 per cent; and the plagioclase, 15 to 20 per cent. The groundmasses in the smaller dikes and along the margins of the larger ones, where cooling has been most rapid, are so minutely granophytic that the interpenetration of quartz and orthoclase can scarcely be distinguished. The groundmasses appear to be made up of confused, poorly defined granules. Similar but less finely crystalline material in the more slowly cooled parts of the rock consist of regular granophytic intergrowths of the hemispherulitic and sheet-like kind. The orthoclase is estimated to form about 45 per cent of the groundmass and the quartz about 25 per cent. Through the groundmasses are scattered small grains of zircon, apatite, and magnetite. Secondary minerals include chlorite, sericite, and zoisite. The biotite has the same reddish tone as in the granite porphyry and other dikes.

Porphyritic quartz monzonite

The stock of porphyritic quartz monzonite covers about one-half square mile on lower Beauty Creek, mostly on the slope on the north side of the creek (pl. 2). It is fringed by dikes of rhyolite and granite porphyries, but none was observed to extend into the stock itself. Most of the ore deposits in the Beauty Bay district occur near the margins of the stock and a few are within.

Most of the stock is conspicuously porphyritic and contains scattered crystals of orthoclase as much as 30 millimeters long in a grayish, medium-grained, granular rock, the average grains of which measure about 2 millimeters. Its minerals include about 15 per cent biotite (1 millimeter grains); 30 per cent zoned andesine; 30 per cent orthoclase; 25 per cent quartz; and such minor accessories as zircon, apatite, and magnetite. The centers of the andesine crystals are largely altered to sericitic aggregates, but the outer zones are clear and have a composition of sodic andesine. The orthoclase penetrates irregularly into the andesine crystals and commonly holds them as corroded and embayed, or as shadow-like inclusions, visible in the phenocrysts with the unaided eye. Some chlorite and epidote are also present in the rock with relations much like those in the granodiorite at Beyview. This rock, like the older Mesozoic rock, has been considerably modified by end-stage processes.

Basic dikes

The basic dikes are more numerous and more widely distributed than any of the others, but are rarely exposed, except in underground workings and in road cuts. Their presence elsewhere is inferred from the distribution of weathered rock fragments in the soil. They seem most abundant in the Wolf Lodge area and appear in nearly every out along the U. S. No. 10 highway from Wolf Lodge Bay to the Fourth of July summit. These dikes are from 10 to 60 feet thick and dip at steep angles, their positions and distribution controlled by faults. Dikes exposed in underground workings are generally less than 10 feet thick.

Most of these dark colored dikes are fine-grained, nonporphyritic; but some are conspicuously porphyritic and contain biotite and augite as phenocrysts. Those without phenocrysts appear to be typically diabasic, and those with phenocrysts, typically lamprophyric. However, there are gradations between them, both texturally and mineralogically. They are probably related genetically, although they may not be precisely of the same age.
Diabasic rocks

The diabasic dikes appear to be most numerous in the Wolf Lodge area. Most of them are biotite diabases, which, with increase in hornblende, pass into hornblende-biotite diabases, and, with increase in biotite and augite, pass into lamprophyric varieties. The biotite diabase is a dark gray, fine-to-medium-grained rock which generally contains abundant biotite grains less than 0.5 millimeter in diameter in the smaller, fine-grained dikes and 1.0 millimeter in the larger, coarser-grained ones. No other minerals are clearly distinguishable in the hand specimen, but, in thin section, labradorite, hornblende, and calcite pseudomorphs after olivine are conspicuous, as well as minor amounts of apatite, magnetite, zircon, quartz, and orthoclase. The labradorite occurs as euhedral laths with biotite anhedral occupying the interstices between laths in the same way that augite cements and encloses the plagioclase in normal augite diabases. The texture of the rock is typically diabasic. The labradorite forms from 60 to 60 per cent of the rock; the biotite, from 20 to 25 per cent. The biotite has the reddish tones characteristic of those of the rhyolite porphyries and related dikes and also of the associated lamprophyres. The hornblende content is variable and ranges from less than 5 per cent to as much as 15 per cent, but its grains are not conspicuous because most of them are altered to chlorite. The olivine, recognized only by the rounded outlines and magnetite-accentuated cleavage, comprises about 5 per cent of the rock. Magnetite and apatite are both relatively abundant, the apatite appearing in the form of long needles. Quartz and orthoclase each comprise less than 5 per cent of the rock. Chlorite and calcite are abundant as alteration products of the hornblende and olivine, but the labradorite and biotite grains are perfectly fresh. Some dikes contain a few corroded intratelluric plagioclase and quartz crystals like those in the rhyolite porphyry.

The hornblende-biotite diabase contains somewhat more hornblende than biotite and has some augite in place of olivine, but otherwise there is little difference either in grain size or mineralogy. The biotite grains are not as conspicuous as in the biotite diabase and the hornblende is not so completely altered. The plagioclase is highly zoned labradorite and is in a matrix of both biotite and hornblende. Other minerals are accessory quartz, orthoclase, magnetite, and apatite and considerable secondary calcite, chlorite, and sericite mica. The dark minerals compose about 35 per cent of the rock.

Lamprophyric rocks

The lamprophyric rocks were observed only underground. Specimens for microscopic study were collected at the Gray Wolf property in the Beauty Bay district and at the Rainbow property at the head of Evans Creek. In some of the rocks, which are biotite-augite lamprophyres, the biotite is slightly more abundant than the augite; in others, the augite is slightly in excess of the biotite. Most of them, perhaps, should be classed as kersantites. These rocks are deeply weathered at the surface.

The lamprophyric rocks are dark gray, perphyric, and contain numerous biotite crystals from 0.5 to 2.0 millimeters in diameter and less conspicuous augite crystals in fine-grained groundmasses composed largely of zoned andesine with minor amounts of orthoclase, augite, and biotite, and a few grains of apatite, magnetite, and zircon. The dark minerals, biotite and augite, compose about half of the rock; the plagioclase, much of the remainder. The minerals are generally considerably altered, particularly to chlorite, sericite, and calcite.

Associated metamorphism

The Frichead formation which encloses the stock of porphyritic quartz monzonite on Beauty Creek shows marked changes in appearance near the margin of the
stock. Its color becomes much darker and its rock, less like shale and more like hornfels or finely micaceous quartzite with numerous, minute, scarcely distinguishable grains of biotite. The weathered rock has a dark rusty appearance, much more pronounced than in the Prichard strata elsewhere. Underground, the unweathered rock is a dark, finely micaceous quartzite which may be easily mistaken for basic igneous rock.

A specimen of the less highly altered quartzite from the face of the tunnel at the Royal property a short distance east of the stock shows lavender spots and bands in an otherwise grayish, fine-grained rock, containing minute but visible grains of biotite, in part larger and more conspicuous along than across bedding and cleavage planes. In thin section, the rock is microgranular and has scattered grains of reddish-tinted biotite, similar to those in the dikes, and scattered crystals of magnetite in an intimate aggregate of more minute quartz and sericite grains. The biotite is mostly concentrated in spots, and the lavender tint of the rock is due to the distribution of these reddish biotite grains. A few widely distributed zircon crystals are present also.

Another specimen adjacent to the stock at the Caribou property appears to be more highly altered. It also has a lavender-tinted, grayish color, but looks more like a fine-grained igneous rock (hornfels) than like quartzite. It is without lavender spots, but has instead spots and small blotches of lighter color. Some of these are composed of quartz mosaics and others are made up largely of poorly twinned, plagioclase laths associated with minor amounts of reddish biotite, hornblende, pyroxene, and accessory magnetite, sillimanite, and quartz. The plagioclase has an index of refraction above that of balsam, but below that of quartz. Its composition is probably a sodic andesine. Grain borders are not well-defined, but the texture of the rock has some resemblance to the diabase. There is no evidence that these spots are inclusions, but their relations appear to indicate that they have formed in the quartzite by replacement.

The changes in the rock just described suggest progressive exomorphism of the Prichard by emanations associated with the intrusion of the porphyritic quartz monzonite, and to some extent with the intrusion of the granite and rhyolite porphyries. Sericite was apparently formed during the feeblest stages of exomorphism; but, as the exomorphism increased in intensity, the sericite was replaced by biotite and in the most advanced stages by plagioclase, hornblende, and pyroxene, thereby converting the impure quartzite and shale to an igneous-like hornfels, which has marked resemblance to some of the basic dikes.

Extrusive Rocks

Columbia River basalt

The Columbia River basalt is the only extrusive rock in Kootenai County and forms the flows that underlie the plateau in the southwest part of the county and the broad terraces on both sides of Coeur d'Alene Lake, the Coeur d'Alene River, and the east side of the Purcell Trench as far north as Corbin junction (pl. 2). These flows formerly extended far up the Coeur d'Alene River and the Purcell Trench, but erosion has since removed them, except for the above mentioned terraces remnants. The number of flows is not known, but few followed flow until the lower foothills country was covered and the lava had flooded far back into the mountains to the present 2500-to-2700-foot contour. Their extrusion is thought to have taken place during the middle Miocene. 1

no more than differences within individual flows. The tops and bottoms of the flows are generally more vesicular than the middle, and the vesicles are usually larger; but the only other difference is that the rock near the top and bottom generally has more glass than the rock farther within.

The basalt is dark gray to black and fine-grained to aphanitic; but some has large scattered crystals of labradorite and, therefore, is somewhat porphyritic. Much of it is actually subophitic in thin section as it contains some labradorite and augite in grains somewhat larger than the average. The labradorite laths are commonly partly enveloped by the augite crystals or cemented by smaller augite grains, brownish glass, and crystals of magnetite, ilmenite, and apatite. Glass occurs through the rock in each of the flows, but is most abundant near the top where it may form from 25 to 50 per cent of the rock. The glass apparently consists of uncrystallized augite, magnetite, and ilmenite. The augite has the brownish color generally accorded to the presence of titanium.

**STRUCTURE**

**Foreword**

The structural features of Kootenai County are extremely complex and are the result of folding and faulting on a large scale. The short time spent in the district, however, permitted recognition of only the major structural features and did not allow a record to be made of the detailed structural relations. The faulting in particular is extremely complicated, but fortunately is confined mostly to certain broad zones associated with folding. In these zones, faults are numerous, but recognition of those of less than a few hundred feet displacement is in most places impossible because of the similar lithologic character of the rocks through hundreds and even thousands of feet of section. The folds and faults are both important because of their relation to igneous intrusion and mineralization.

**Folding**

Except in the northeast part of the county, the Belt strata have been arched into a broad antiline, broken, however, by several longitudinal faults of large magnitude and by other faults of smaller size and more variable trend (pl. 2). This broad antiline may be regarded as the dominant structural feature of the county because of its association with faulting and igneous intrusion, and because most of the mineral deposits of the district are grouped along its crest and flanks. It has a general west-northwest trend, and may be traced across the county from the Shoshone County line on the east to Lake Coeur d'Alene and the Purcell Trench on the west. The arching has brought the Frichard formation to view along the crest of the antiline and has exposed each of the successively younger formations from the Burke to the Striped Peak on its flanks. On the south flank, the strata dip at moderate angles to the southwest; on the north flank, at moderate angles to the northeast. The arch is broad and its span covers 25 or more miles. Its southwest flank lies partly in Benewah County, but its northeast flank is within Kootenai County and intersects a folded and faulted structure of diametrically opposed trend and dip.

In the northeast part of the county, the strata are much less disturbed and form the eastern limb of a faulted fold. Their prevailing strike is approximately north-northeast and their dip southeast or at right angles to the broad arch on the south. This northeast-trending structure passes into Shoshone County and may be traced northeastward, with few interruptions, to the Clark Fork River. Its relations to the northwest-trending arch are difficult to determine from reconnaissance study, but it appears to have been formed earlier than the arch and to
have been disturbed by it. Unlike that of the northwest-trending arch, the origin of this fold apparently was not associated with igneous intrusion and had little or no control of mineralization.

Faulting

The geographic distribution and structural relations of the faults place them naturally into three groups. The first includes those along the crest and flanks of the major northwest-trending anticlinal uplift; the second, those of considerable magnitude near the southeast margin of the Purcell Trench, south of Pend Oreille Lake, and somewhat different in character from those along the anticlinal uplift; the third, longitudinal faults of great length in the less disturbed northeast part of the county.

Faults associated with the northwest-trending uplift

The faults associated with the northwest-trending arch include some of the most famous faults in northern Idaho, namely, the Osburn and Placer Creek faults of the Coeur d'Alene district. To these may be added two others of equal magnitude, heretofore unrecognized, the Burnt Cabin and the St. Joe. These faults conform approximately with the general trend of the anticlinal structure, and, therefore, are longitudinal faults. There are also many faults of lesser magnitude, some of which approximately parallel the major faults whereas others extend transversely across the anticlinal uplift end against the major longitudinal faults. These major faults appear to be of the normal variety, with the hanging wall relatively down-thrown, but the minor faults are in part normal and in part reverse. The fault pattern is exceedingly complex, and, if all faults were recorded on the map, would probably reveal a rather well defined mosaic dominated by the major faults of northwest trend.

Osburn fault

The Osburn fault was readily traced by the alignment of saddles and by the zone of intensely deformed rock from CATALDO at the Shoshone County line through the saddle at the Fourth of July summit to Fernan Lake at Coeur d'Alene City (pl. 2). Although of major geologic importance, it is probably not so pronounced a tectonic feature in Kootenai County as it is in Shoshone County. It appears to decrease in magnitude west of the Fourth of July summit, but may still be recognized at Coeur d'Alene where it disappears from view beneath the gravels of the Purcell Trench. So far as could be determined from surface observations, the fault dips steeply south and its downdraft has likewise been to the south. The strata on either side of the fault belong to the upper Frichard and the apparent displacement has probably not been more than 1,000 feet. No evidence of a pronounced horizontal movement was observed such as has been reported to exist in Shoshone County in the Coeur d'Alene district, where the displacement is reported to exceed 10 miles. Instead, the displacement appears to have been largely vertical, produced by the action of vertical rather than horizontal stresses. Its strike is about parallel to the axis of the major northwest anticlinal arch, but its position is several miles from the crest of the anticline well out on the north flank.

Placer Creek fault

The Placer Creek fault is also one of great persistence, although the displacement along it is probably not nearly so much as the displacement along the Osburn fault. It lies several miles south of the Osburn and has been traced across

Shoshone County in an east-west direction from the Continental Divide to the
Kootenai County line. It also extends some distance into Kootenai County (pl. 2).
It is bordered by the Burke formation for several miles after it enters Kootenai
County, but, if it extends north of the Coeur d'Alene River, it is in the Prichard.
The fault trace is expressed in the topography and is marked by an alignment of
low saddles that may be seen for miles from points of vantage. The fault lies
very near the axis of the broad uplift and its dip, like that of the Osburn fault,
is probably steeply south.

Burnt Cabin fault

The Burnt Cabin fault is more strikingly reflected in the topography than
either the Osburn or Placer Creek faults. It passes through the low saddle at the
head of Burnt Cabin Creek and may be readily traced northwest several miles toward
the head of Hayden Lake. It extends southeast into Shoshone County where it joins
one of those mapped about 3 miles north of the Osburn fault. It has had a marked
control on the course of Burnt Cabin and Deception creeks and other streams along
its path, and its course is accentuated further by particularly deep and prominent
saddles across all ridges. Its strike is more northwest than west-northwest, and
in Shoshone County it draws near the Osburn fault. It is bordered by rocks of
different formations, by Prichard and Burke near the Shoshone County line, and by
Burke and St. Regis farther west. The fault zone is broad and complex and appar-
ently has many subsidiary fractures. Its displacement probably exceeds several
thousand feet, and, like the Osburn, the fault is probably normal. The fault
plane, however, appears to dip steeply northeast and lies well out on the north-
west flank of the anticlinal arch. This fault is of considerable importance be-
cause many of the mineral deposits within the county are in its vicinity.

St. Joe fault

The St. Joe fault lies near and trends roughly parallel to the St. Joe River.
It extends from the south border of Kootenai County across Benewah and far into
Shoshone County. Its course is marked by an alignment of deep saddles extending
from the plateau surface at Harrison Flats far up the St. Joe Valley. This fault
is normal with downthrow on the south. In Kootenai County the Burke, or Revett,
formation lies against the Prichard and farther east the Wallace against the
Prichard. It cuts the far south flank of the anticlinal arch. Locally, near
St. Maries, it has apparently localized igneous intrusion and mineralization.

Other faults of west-northwest trend

In the southeast quarter of the county there are several other faults of
west-northwest trend but of lesser magnitude than those described. Some of the
faults south of the Osburn are shown on the map (pl. 2). Most of them are not
conspicuously expressed in the topography, and may not be so persistent along the
strike as are the others. They appear to be normal, with steep dip either north
or south, and to occur along the crest and flanks of the anticlinal uplift.

Transverse faults

The transverse faults are not known to cross any of the longitudinal faults,
but instead appear to be cut off by or to end against them. They have a north-
early trend, about at right angles to the axis of the major anticline. Most of
them are bounded by Burke and Revett beds on one side and Prichard on the other
and appear to have considerable displacement. They seemingly are normal faults
of steep dip. Several of the larger ones lie north of the Osburn fault and ex-
tend north to the Burnt Cabin fault (pl. 2). Others occur between the Osburn and
Placer Creek and between the Placer Creek and the St. Joe faults. Some of these
faults may be older than the longitudinal faults, but others are more likely about contemporaneous.

Fault mosaics

In addition to the earth fractures of major magnitude, there are many faults of relatively minor displacement and of variable strike and dip, which, if mapped in detail, would describe a typical fault mosaic. Most of these faults are short as they are abruptly cut off either by other minor faults or by the major longitudinal faults. Unfortunately, few of the minor faults could be mapped as they are more difficult to recognize than the others and are mostly revealed by abrupt changes in strike and dip of the sedimentary strata and not by topographic irregularities. Enough were mapped south of the Coeur d'Alene River between Cataldo and Rose Lake to bring out their general features and broader relationships. Their displacement is not sufficiently large to bring different formations of the Belt series into juxtaposition unless the faults are exposed close to formational contacts. These faults are of particular interest because their characteristic features are those usually associated with collapse or adjustment to igneous intrusion. They may have either normal or reverse displacements.

Other faults

There are also other faults of minor magnitude which are rarely reflected in the topography, but which occur in the vicinity of major faults and are mostly parallel to them. These minor fractures, however, are of great importance for those along which there has been no great displacement and which contain only small amounts of gouge may contain veins. Most of them appear to be reverse faults, along which the hanging wall has moved upward. Movement along them has produced either fault fissures, complex fractures, or breccia zones. Those with normal displacement appear to have considerable gouge and are generally unmineralized.

Origin of the faulting

The grouping of the faults along the axis and flanks of the broad anticlinal uplift suggests a genetic relationship between arching and faulting, and, as igneous intrusion has likewise been localized along the central part of the arch, it suggests a relation also between arching, faulting, and igneous intrusion. The faults have broken the anticlinal structure and at the same time have guided the intrusion of igneous dikes from an underlying magma body, which, because of the widespread distribution of dikes and mineral deposits, must underlie the arch for its full length. These dikes were emplaced over a period of time, probably throughout the larger part of the period of faulting, a fact that tends to link the faulting and intrusion even more closely together and also to relate them to the structural uplift. As the reverse faults have apparently been formed by lifting forces, the reverse and mosaic faults and the arching may owe their origin more or less directly to intrusion; but the large longitudinal and most of the transverse faults, which have broken the arch, apparently owe their origin to collapse during and following the uplift, probably in response to adjustments within the underlying magma body. It is concluded, therefore, that the faults associated with the anticlinal uplift are products of the lifting forces that accompanied igneous intrusion and the result of collapse.

Pend Oreille fault mosaic

A zone of faults also extends along the western border of the mountainous area from the south end of Pend Oreille Lake nearly to Coeur d'Alene, and is a continuation of the zone of block faults described by Sampson in the Pend Oreille district.

These faults describe a regular mosaic pattern and are earth fractures of steep dip but without systematic trend. These have broken the crust into a jumble of blocks, some of which have been subjected to marked displacement. Time did not permit the mapping of more than a few of the larger faults, and, therefore, the geologic map (pl. 2) does not show them as adequately as does Sampson’s map of the Pend Oreille district. The faults have been classed by Sampson as intrusion and post-intrusion faults, and he has considered them as adjustments to batholithic intrusion. The intensity of faulting dies away from the margin of the batholith so that the faults become smaller and more widely spaced.

Other faults

The Pack saddle, a post-intrusion fault that borders the zone of mosaic faults on the east, is an earth fracture of large magnitude which Sampson has traced from Kootenai County to the Clark Fork River. It extends a few miles into Kootenai County, but loses its identity near the headwaters of the Little North Fork. Its displacement is variable, but in places the displacement has brought Wallace and Striped Peak beds against the Burke formation. East of the fault the strata have been little disturbed by faulting, and, therefore, the Pack saddle serves to separate an area of greatly faulted rock on the west from one of relatively simple structure on the east.

There are, however, several faults of considerable magnitude east of the Pack saddle. One of these has brought the Wallace formation on the west against the Burke and the St. Regis beds on the east. This fault has a northwesterly trend and about conforms with the strike of the strata. Little was learned of its characteristic features and origin although it may be rather intimately related to the folding of northeast trend and may be cut off on the south by the faults of west-northwest trend that are associated with the major anticlinal uplift. Still another fault lies to the east and has brought the Wallace again in contact with the Burke and the St. Regis formations.

Faults are also numerous on the gneissoid rocks along the western margin of the county as indicated by shearing, by abrupt changes in strike and dip of the foliation, and by alignment of saddles. No attempt was made to map them. The faults in the gneissic complex west of Coeur d’Alene Lake may in part conform with those on the east side of the lake and may form a part of the system associated with the collapse of the west-northwest-trending structural arch; but others form a mosaic that probably conforms with the Pend Oreille fault system.

Age of folding and faulting

The relations of folds and faults within the county suggest at least two periods of deformation, the older producing the folds of northeasterly trend and the complex fault-block mosaics about the margin of the batholithic bodies, and the younger the complexly faulted transverse, anticlinal uplift of west-northwest trend. The earlier northeast-trending folds probably accompanied the deformation associated with the batholithic intrusion; and, as the batholiths are believed to have emplaced during the late Jurassic or early Cretaceous orogeny, the associated folds and faults are therefore also probably late Jurassic or Cretaceous. The faulted anticlinal structure of west-northwest trend, however, is associated with younger hypabyssal intrusive rocks, and, as the intrusives are regarded as early Tertiary, the anticlinal uplift and faults are probably a manifestation of the Laramide disturbance of late Cretaceous or early Tertiary time.

ORE DEPOSITS

HISTORY

Some of the ore deposits in Kootenai County were discovered during the early eighties when prospectors from the gold fields of California spread over the Coeur d'Alene region. Many of these deposits were extensively explored, but none of them was found to contain ore of commercial grade and most of them were abandoned. A few continued to attract attention and were explored sporadically for many years. Other deposits were later discovered so that mining activity was never at a standstill. The high prices for metals during and shortly after the World War served to stimulate search for new deposits and to revive interest in old, but, with the subsequent collapse of the metal market, interest dwindled until 1923 when reported rich platinum discoveries lead to intense excitement. Several plants of special design were erected to recover the platinum "ore" from several of the properties, but, before these mills were in actual operation, the platinum "discoveries" proved to be a hoax. Small bodies of lead-zinc ore, however, had been uncovered in the Beauty Bay district, and these continued to attract attention. In 1929, a mill on the Caribou property was equipped to do custom milling and during 1931 treated ore from several deposits in the Beauty Bay district. This mill was in operation for but a short time when the low price of lead and zinc discouraged any further activity. Work continued, however, in other parts of the county, particularly in the Hayden Lake district and more recently along the Little North Fork. During 1937, several companies were organized to promote development of properties in other parts of Kootenai County.

The production from Kootenai County has been negligible. Aside from a very small production in the Beauty Bay district, the only other production has been from the Commonwealth mine in the Hayden Lake district, but the amount produced there was not learned.

GENERAL CHARACTER

The ore deposits in Kootenai County are in general similar to those in Shoshone County but are more diverse as to kind and substance. They may be classified as either replacement deposits or fissure fillings, and contain ores of lead, zinc, silver, copper, arsenic, bismuth, and berilum. The fissure fillings are composed largely of quartz and contain scat but variable amounts of metallic minerals and carbonates. The replacement deposits include a group of high-temperature lead-zinc, pyrrhotite and arsenopyrite, and a group of moderate-temperature lead-zinc-siderite, siderite, silver, and berilite deposits.

DISTRIBUTION

Geographic distribution

The ore deposits are not uniformly distributed throughout the county, but occur along certain mineralized zones related to geologic structure and are mostly concentrated in relatively small areas. The mineral deposits are confined to the area of the Coeur d'Alene Mountains with special centers of mineralization along the lower course of the Little North Fork, near Hayden Lake, along Wolf Lodge and Beauty bays, near and along the Fourth of July Canyon, along the Coeur d'Alene River from Rose Lake to Lame, on both sides of Killarney Lake, at the head of Pine Creek, and at the head of Evans Creek. The Little North Fork and Hayden Lake areas, although widely separated, are along a west-northwest zone of mineralization.

The deposits along the Fourth of July Canyon, as well as some of those along the Coeur d'Alene River and on Wolf Lodge Bay, are similarly aligned along another zone. The Beauty Bay district is a unit in itself. The deposits at the head of Pine Creek are at the outskirts of the Pine Creek district of Shoshone County, and the deposits at the head of Evans Creek are at the border of the Roundtop district of Benewah County.

Although the mineral deposits are rather widely scattered, the different metals tend to favor certain broad areas: lead-zinc-pyrrhotite ores, the Beauty Bay and Roundtop districts; copper and lead-zinc-siderite ores, the Little North Fork; siderite, the Pine Creek; and quartz veins with small but variable amounts of sulphides, much of the remainder. Bismuth-quartz veins, however, occur only in the Beauty Bay district.

**Geologic distribution**

The distribution of the mineral deposits conforms closely with geologic structure and the deposits are mostly scattered along the crest and flanks of the extensively faulted antecedent uplift of west-northwest trend, especially in the zones of most intense deformation defined by the major west-northwest-trending faults. The deposits along the Little North Fork and near Hayden Lake are near or along the zone of the Burnt Cabin fault; those along the Fourth of July Canyon and Wolf Lodge Creek are near or along the zone of the Osburn fault, and those near the Coeur d'Alene River and in the Beauty Bay district are along other west-northwest fault zones of more or less major magnitude. The Roundtop district likewise is near the zone of the large St. Joe fault. Although some of the Hayden Lake deposits are localized by the Burnt Cabin fault, others are more directly controlled by fractures related to the older Fond Oreille mosaic of faults. Although the mineralization is confined to the zones of most pronounced structural disturbance, the ore bodies do not lie along the major faults but favor the minor fractures for some distance on either side.

The mineral deposits are not confined to any one formation but have been observed in all members of the Salt series, except in the Striped Peak formation. They are most numerous in the Priehard and Wallace because these formations are the thickest and have the widest areal distribution. These formations incidentally are in the zones of most pronounced structural disturbance and are cut by the major west-northwest faults along which much of the mineralization has been localized. Some of the Durko, Revett, and St. Regis beds also contain deposits; and one at least is contained in a pre-Cambrian sill. Bismuth-quartz veins are in the porphyritic quartz monzonite, but igneous rocks elsewhere are devoid of mineral deposits, the granodiorite bodies and gneissoid rocks particularly showing very little evidence of mineralization.

**CLASSIFICATION**

The mineral deposits may be classed broadly according to whether the ore made space for itself by replacing the confining walls of fissure or fracture zones, or to whether the ore filled preexisting spaces. They may be classed, therefore, either as replacement deposits or as fissure fillings. Such division, however, is not adequate to take care of substance and genetic differences, and further subdivision is useful. Several schemes of classification might be proposed. One based on genesis, as hypothermal and mesothermal deposits, has much to commend it; but one based on structure and substance is probably of greatest value and is here used.
Classification of ore deposits

Replacement deposits
- Lead-zinc-pyrrhotite
- Aresnopyrite
- Lead-zinc-siderite
- Siderite
- Silver-lead
- Specularite-ankerite

Fissure fillings
- Copper-quartz
- Lead-zinc-quartz
- Silver-quartz
- Bismuth-quartz
- Quartz
- Specularite-barite

DESCRIPTION OF THE DEPOSITS

Lead-zinc-pyrrhotite deposits

Geographic distribution

The lead-zinc-pyrrhotite deposits are confined to the Beauty Bay and Roundtop districts and have examples deposits on the Caribou, Gray Wolf, Silver Tip, and Johnny Mac properties along Beauty Creek and on the Rainbow No. 3 at the head of Evans Creek in the Roundtop district. The two districts are widely separated, but the character of the mineralization in each is remarkably similar, and deposition has apparently taken place under essentially identical geologic conditions.

Structural relations

The deposits in both districts are replacements along complex fracture zones in the quartzitic beds of the Prichard formation and are not far from bodies of intrusive porphyritic rocks. The Beauty Bay deposits are near the body of porphyritic quartz monzonite or near dikes of rhyolite porphyry, whereas the deposits in the Roundtop district also are near bodies of granite and rhyolite porphyry. In each place, igneous intrusion and mineralization have been localized in the vicinity of major west-northwest faults, and the ore deposits are confined to minor zones of fracturing along which the rock has been considerably shattered but not much displaced.

The mineral-bearing fracture zones are commonly of considerable length and breadth, and may be traced on the ground and beneath the surface for distances of several hundred to several thousand feet. The entire fracture zone may be from 100 to 200 feet wide, but only a small part actually contains ore and the more highly mineralized parts generally do not exceed 5 feet. Through much of the zone the fractures are rather widely spaced, but are more highly concentrated near and along the present ore bodies. The fracture zones are for the most part without well defined walls, but pass by degrees into unbroken quartzite. Displacement along them probably has not been more than a few feet, but total displacements are difficult to determine in strata of such uniform lithology, and

displacements of 100 feet or more might go unrecognized.

The zones of fracturing may accord with the trend of the major west-northwest faults or with the general trend of the less prominent transverse faults. In the Roundtop district the trend is west-northwest, but in the Beauty Bay district most of the mineralized fracture zones trend in a northerly direction, their strike a few degrees either east or west of north, or alternating from one side to the other.

In some places the fracture zones are difficult to distinguish from the dark, rusty, metamorphosed though unbroken Prichard strata, but the outcrop is generally marked by a somewhat heavier iron staining and by its superior tendency to resist erosion and form ledges. Underground, distinction may be made by the relative intensity of the wall rock alteration and by the widespread distribution of small amounts of sulphides. The wall rock alteration has had a tendency to darken the rock.

The ore minerals are not uniformly distributed through the fracture zones but occur in small shoots or bunches along the most extensively fractured and altered rock. These bodies are generally without definite walls but shade into the altered wall rocks. The ore, therefore, is frozen to the country rock unless separated by postmineral faults. Much of the ore is in massive form, consisting largely or wholly of sulphides, but sulphide grains and pods may impregnate the walls for some distance from the massive ore zone. The main sulphide bodies in the Beauty Bay district are generally from 2 to 5 feet thick and up to 150 feet long, but in the Roundtop they exceed 10 feet in thickness where, however, much altered rock is also included. Much of the ore at the Rainbow appears to occur as thin seams and veinlets filling the fractures in the altered quartzite and replacing the rock alongside. All sulphides are not ore minerals; the valuable minerals are in considerably smaller seams, lenses, and bunches in the sulphiderich zones.

Mineralogy

The mineralization has consisted largely in the replacement and impregnation of the altered quartzitic beds by massive sulphides. Very little quartz (SiO₂) and carbonate have been deposited with the sulphides; the chief gangue mineral, therefore, is the altered country rock. The sulphide assemblage includes pyrrhotite (Fe₇S₈), locally as much arsenopyrite (Fe₅AsS₄), and variable though lesser amounts of pyrite (FeS₂), sphalerite (ZnS), and galena (PbS). Chalcopyrite (CuFeS₂) may be present in very scant amounts, mostly as microscopic blebs in the sphalerite.

Some deposits are composed almost wholly of pyrrhotite; others, of arsenopyrite; but none has a preponderance of either sphalerite or galena. The latter are generally confined to smaller pods, seams, and small pockets in and cutting the pyrrhotite and arsenopyrite.

The sulphides are mainly medium grained and the minerals, except chalcopyrite, are readily visible to the unaided eye. The sphalerite is dark colored and is filled with microscopic pyrrhotite and chalcopyrite blebs aligned along crystallographic partings. The galena may show its prominent subbladed cleavage or may be granular. The various sulphides are commonly intimately associated or complexly admixed, but galena and sphalerite may appear as seams or pods of the pure minerals.

Deposition of the sulphides has taken place in more or less orderly sequence little disturbed by concurrent structural adjustments. The usual sequence has
been pyrite, arsenopyrite, sphalerite, pyrrhotite, chalcopyrite, and galena. In
some deposits, scant amounts of quartz and/or ankerite preceded the deposition of
sulphides. In a few a little drusy quartz, or chalcedony, and scant amounts of py-
rite and arsenopyrite were deposited later than the essential sulphides. Much
overlapping has apparently taken place during sulphide deposition. The pyrrhotite
may be about contemporaneous with the sphalerite, but some of it is in fractures
penetrating and replacing the sphalerite. In some places, the galena is so in-
timately admixed with the other sulphides as to suggest essentially contemporane-
ous deposition, but in other places it is in seams cutting and replacing other
sulphides.

High platinum assays were reported from this ore during the platinum excite-
ment, but no values have been reported subsequently, and no traces of platinum was
found during the present investigation. The pyrrhotite does not appear to be
associated with pentlandite as no nickel could be found by analysis. The gold
content of the ore scarcely exceeds a trace; but silver is present in small though
variable amounts, depending largely on the abundance of galena.

The presence and abundance of arsenopyrite and pyrrhotite indicate that the
deposits belong to the hypothermal group and that the mineralization was accom-
plished under conditions of high-temperature and under considerable pressure. 

Wall rock alteration

The rock in and along the fracture zones in the Beauty Bay district is con-
siderably darker and has more biotite than the prevailing country rock. At the
margins of the fracture zones, the biotite is fairly widely scattered and is in
poorly-formed grains which occur in clusters. Within the fracture zone the
clusters unite to form crystal individuals. Where scarce sulphides appear along
the fracture zone, the biotite may be altered to chlorite but is generally
changed into aggregates of sericitic mica. Where the sulphides are more abundant,
the biotite disappears altogether and its place is taken by sericite. Sericite
also appears to have replaced much of the quartzite. In the most intensely min-
eralized parts, sericite largely disappears and its place is taken by quartz.
The altered rock remains dark, however, because the sericitized and silicified
rock, which should normally have a light color, is impregnated with disseminated,
dark-colored sulphides.

The alteration is somewhat different at the Rainbow property on Evans Creek.
At the very margin of the alteration zone, the quartzite is dark gray, and its
original quartz grains have been partly replaced by sericite. The quartz and
sericite in turn show replacement by chlorite and small clusters of biotite.
Inward toward the areas of more intense alteration, the sericite grains tend to
become more abundant and to increase in size, and the biotite clusters tend to
enlarge and unite as single crystals. Where grains of pyrrhotite appear in the
rock, chlorite increases in abundance. Near the more intensely mineralized
zones, however, the rock becomes lighter colored; and the sericite, biotite, and
chlorite disappear, their places being taken by quartz, carbonates, and increased
amounts of pyrrhotite.

Because of the presence of numerous small flakes of biotite throughout much
of the zone of alteration, the rock has a distinctive "igneous" appearance, but
in the more intensely altered part resembles a silicified quartzite. Thus, the
general processes of alteration have been sericitization, chloritization, biotit-
ization, carbonatization, and silicification, the different processes overlapping
but in general conforming to the given sequence.

Arsenopyrite deposits

The arseneopyrite deposits are closely affiliated with the lead-zinc-pyrrhotite deposits in the Beauty Bay district and comprise those deposits made up almost entirely of arseneopyrite with but negligible amounts of pyrrhotite or other sulphides. These deposits are mostly near the mouth of Beauty Creek and on the upper slope of Elk Mountain not far from the lead-zinc-pyrrhotite deposits and not far from the quartz monzonite stocks.

The arseneopyrite deposits are smaller and more irregular than the lead-zinc-pyrrhotite deposits and occur as short, narrow, overlapping veins from 1 to 3 feet thick and from 20 to 30 feet long; but some occur as large, lenticular or chimney-like bodies as much as 15 feet thick and 100 feet long. Some of the deposits have a northeast strike; others strike northwest. The arseneopyrite has largely replaced the fractured quartzite of the Frichard formation and occurs in massive form in bounces and nests or in seams and bands several inches thick, cementing the brecciated quartzite.

The arseneopyrite is usually accompanied by a little quartz and pyrite, but the principal gangue is composed of fragments of unremoved country rock. Cobalt bloom occurs on some of the exposed arseneopyrite ore, but no primary cobalt minerals were recognized in polished surfaces. Some of the deposits were slightly reopened by structural adjustments after the arseneopyrite had been deposited, and minor amounts of drusy quartz were added in open fractures.

Lead-zinc-siderite deposits

Geographic distribution

Only one lead-zinc-siderite deposit was found in the county. It occurs along the Little North Fork of the Coeur d'Alene River in an area which is better known for its copper veins than for its lead-zinc-siderite deposits. This deposit as well as several copper-vein veins occur near the Riverside property some distance within the borders of the Little North Fork mining district.

Structural relations

The deposit is a short distance from the Burnt Cabin fault and, therefore, is along the zone of disturbance of a major west-northwest earth fracture. It lies, however, along a subordinate fracture zone of rather intense deformation in which the upper black clayey shales and argillites of the Wallace formation have been exceptionally deformed and dip almost vertically. The fracture zone is not less than 300 feet wide, but the ore body lies near the footwall where the beds have been most extensively shattered and where fracture cleavage is very prominent. The ore body itself is as much as 6 feet wide and 40 feet long, but the full limits of the mineralized zone have not been exposed. The rock throughout the fracture zone is extensively bleached and has a pale greenish-gray color, most marked near the ore body. The fracture zone and ore body strike about N. 80° W. and dip about 75° NE.

The ore is sporadically distributed through the shattered rock of the ore zone, mainly as irregular bounces and seams shadding into and replacing the fragments of country rock. The limits of the ore body, therefore, are not sharply defined.

Mineralogy

The ore consists mostly of sphalrite and galena with minor amounts of chalcopyrite, tetrahedrite (Cu₆S₈Cu₃S₂Sb₃S₂), and pyrite in a gangue of quartz.
siderite (FeCO₃), and altered country rock. The sulphides occur mostly as nests, bunches, and seams penetrating into and replacing siderite and quartz, or enclosing and replacing breccia fragments of the altered country rock. Most of the galena is coarsely granular but the sphalerite is fine-grained. Some of the galena is in bands 1 to 2 inches thick. The quantity of sphalerite and galena deposited oxides that of all other sulphides and gangue minerals combined. Siderite is fairly abundant, but quartz is present in very small amounts.

Mineral deposition apparently was disturbed repeatedly by structural movements so that the mineral assemblage was deposited in stages. Quarts and scant amounts of pyrite were apparently the minerals first deposited and then were largely replaced by siderite. Deposition of siderite was also accompanied by deposition of minor amounts of pyrite. The quartz filling was apparently considerably brecciated before the siderite was introduced. Additional pyrite and then sphalerite, tetrahedrite, chalcopyrite, and galena were introduced after the siderite filling had been rather thoroughly brecciated. Some quartz was added later to widely spaced fractures in the sulphides.

Wall rock alteration

The rock throughout the fracture zone has been more or less intensely bleached and has lost most of its original black color. Some dark bands and breccia-like inclusions are retained near the margin, but elsewhere the rock is light grayish-gray and in large part has a distinct pearly luster. The unleached rock contains little or no sericite, but within the zone of alteration sericite becomes the most conspicuous mineral. The partly bleached or altered rock has only minor amounts of it, but where the bleaching is more marked the sericite is much more abundant. It appears to replace only the quartz in the less altered rock, but in the more intensely altered zone the sericite also replaces the primary carbonates. In the most intensely deformed and altered rock in and along the ore zone, the sericite partly disappears and its places are taken by quartz.

The bleaching of the rock, therefore, has been accomplished by widespread and intense sericitization and is much like that associated with the lead-silver-siderite deposits in the Coeur d'Alene district. Silification has in part masked the earlier stage of sericitization immediately adjacent to the ore.

Siderite deposits

The siderite deposits are confined to the Pine Creek district in the extreme southeast corner of Kootenai County in the little disturbed beds of the Burke formation. They are replacement deposits along steeply dipping fault fissures which have not displaced the beds for more than a few feet. The fracture system is fairly complex and consists of a major fissure bordered by a set of minor fractures or gashes which extend outward at oblique angles for distances up to 80 feet. Both the main fissure and the gashes contain siderite, formed mostly by replacement of the finely altered wall rock. The deposits are very irregular in size and in the distribution of siderite. The deposit in the main fissure is from 1 to 2 feet thick but locally swells to 5 feet. The deposits in the gashes are about the same size, but one of them swells into a chimney-like body 10 feet in diameter.

The mineralogy of the deposits is simple as the siderite is essentially the only mineral present. It is accompanied in places, however, by small amounts of quartz and by scattered grains and crystals of pyrite and arsenopyrite, and is cut locally by thin seams of specular hematite (Fe₂O₃). Small bunches of galena have been reported. The deposits show little evidence of structural adjustment and reopening after the siderite had been deposited and appear to represent the
stage of mineralization common to most of the deposits in the Coeur d'Alene dis-
trict, the stage of gangue deposition that preceded the introduction of the spha-
erite and galena.

Traced along the strike the main fissure shows marked change in mineralogy
and is filled with quartz, barite, and specularite rather than with siderite.

**Silver-lead deposits**

**Distribution**

The Shamrock deposit in the Hayden Lake mining district is the only example
of the silver-lead type of deposit recognized so far in the county. It has no
siderite and as its structural and mineralogical relations are so notably differ-
ent from those of the lead-zinc-siderite deposit, it is given separate treatment.
The deposit is in a district that is otherwise characterized by quartz veins but
is without appreciable amounts of quartz itself.

**Structural relations**

The deposit is an area that has been somewhat faulted, but not otherwise
greatly deformed. It is well on the north flank of the major anticlinal fold
that stretches west-northwest across the county. It lies along a fault of north-
northwest trend, apparently a member of the system of complex faults that characterizes
the structural pattern along the western margin of the Coeur d'Alene Mountains
south of Pend Oreille Lake. The fault cuts the black limy beds of the Walla
Walla formation at about right angles to their strike. It appears of appreciable mag-
nitude, but its direction and amount of displacement have not been determined.

Unlike other types of deposits, this one is not localized along a minor
fracture, but along the major fault itself. The fault zone is more than 60
feet wide and is bounded by a well defined hanging wall underlain by 3 to 6 feet
of intensely mashed and sheared rock, with less extensively crushed and fractured
rock extending to an ill-defined footwall.

The ore is distributed sporadically and in sparse amounts through the less
disturbed rock near the footwall. It occurs largely in the form of small bunches
and nests, few of which are more than a few inches thick or more than a foot long,
and as widely scattered thin seams. These irregularly scattered pockets are mostly
replacements or impregnations of the country rock and are too widely distribut-
ted to be regarded as a source of commercial ore.

**Mineralogy**

The minerals of the deposit include pyrite, galena, tetrahedrite, quartz,
and ferriferous dolomite or ankerite. The pyrite and galena are most conspicuous
and commonly occur as small bunches or massive impregnations of the altered
country rock. The tetrahedrite is not associated with the pyrite and galena, but
occurs with thin seams of quartz in fractures in the rock, apparently independent
of the fractures which controlled the distribution of the pyrite-galena. Both
quartz and carbonate occur in scant amounts and the chief gangue is the altered
country rock. Some of the quartz soaked into the country rock ahead of the py-
rite, galena, and carbonate and some occurs as younger seams containing tetrahe-
drite.

**Wall rock alteration**

The black, limy shales and argillites have been more or less extensively
altered by the mineralizing solutions and have lost their identity along the fault.
zone. The highly meshed rock under the hanging wall has a dark greenish color and in large part composed of chlorite. Through the remainder of the fracture zone the rock is mostly a pale greenish sericite schist, containing in places a little disseminated pyrite. Some of the sericitized rock also contains blotches of the dark green chloritized rock. Near some of the ore seams the sericitized rock has in part been silicified, but sulphides also impregnate the sericitized rock itself.

Specularite-ankerite deposits

The Burnt Cabin deposit at the east margin of the Hayden Lake mining district is the only representative of the specularite-ankerite type of deposit observed in the county. It lies at the head of Burnt Cabin Creek, a tributary of the Little North Fork, almost on the Hayden Lake divide, but a short distance from the prominent Burnt Cabin fault.

The deposit is along a prominent fracture zone about 20 feet wide which cuts obliquely across the upper beds of the St. Regis formation. The entire fracture zone, however, is not mineralized; only that part in which the rock has been most intensely broken. The main deposit is from 3 to 6 feet thick, but scattered ore seams and stringers are distributed throughout the remainder of the fracture zone. The deposit strikes N. 40° to 50° W., about parallel to the main Burnt Cabin fault, and dips 60° SW. Post-mineral movement has produced considerable gouge along parts of the body, especially where it is exposed in the upper workings; but with depth the deposit is frozen to the walls.

The deposit consists largely of ankerite (2CaCO₃·MgCO₃·FeCO₃), quartz, specularite, and pyrite, but contains a little siderite and chalcopyrite. Gelene is reported but was not observed. In the upper level ankerite predominates where it contains minor inclusions of milky-white quartz and is cut and replaced by seams of coarse, platy, specular hematite. At somewhat greater depth, the quantity of ankerite and specular hematite appears to decrease and the amount of quartz to increase. The filling there is mostly quartz penetrated by minor amounts of siderite and cut by thin, widely scattered seams of finely crystalline specularite.

Paragenetic relations indicate that the ankerite and siderite invaded an earlier filling of milky-white quartz containing a scant pyrite-chalcopyrite assemblage. Minor amounts of pyrite were also introduced with the ankerite and siderite. Specularite was introduced still later as were also scant amounts of young quartz and finely crystalline pyrite, which occur as thin crusts in open fractures. The introduction of each group of minerals apparently followed successive reopenings of the fractures. As specularite is commonly believed to have been deposited under conditions of high temperature, its late introduction into a deposit of general mesothermal or moderate-temperature aspect may imply a late accession of heat; however, a deficiency of sulphur, which may have had a greater influence than temperature in the formation of specular hematite, can not be ruled out. The decrease of specularite with depth suggests locally a limited vertical range of deposition.

Copper-quartz veins

All the copper-quartz veins, except one, are in the Little North Fork district and the exception is the Varnum vein in the Wolf Lodge area. The veins along the Little North Fork have previously been classed as copper-siderite veins, but as the veins are composed largely of quartz with no siderite and only minor amounts of ankerite, a reclassification as copper-quartz veins is appropriate. Typical representatives are the Handepike and Hamburg-American veins.
The deposits are along subordinate fissures in the vicinity of the major west-northwest faults, fissures that strike in a more northerly direction than the major faults. The Little North Fork deposits lie near the Burnt Cabin fault and occur in the Burke, St. Regis, or Wallace beds. The Varmin is near the Osburn fault and is in a pre-Cambrian dioritic sill.

The veins are fissure fillings, little modified by replacement. These veins have been traced from 600 to more than 1,600 feet underground. They are mostly less than 3 feet thick, but may range from 1 inch to 5 feet, exceptionally to 8 feet. The veins have been little disturbed by subsequent fault movements, and the vein filling is generally firmly attached to the walls.

The fillings are composed mostly of milky-white, coarsely crystalline quartz, which contains more or less uniformly scattered grains, granules, and irregular bunches of chalcopyrite; much less abundant pyrite, and here and there very minor amounts of widely and irregularly scattered grains of galena and sphalerite. The chalcopyrite is everywhere the predominant sulphide and in many veins, except for minor amounts of pyrite, is the only sulphide. These sulphides generally form less than 5 per cent of the filling. Chalcocite occurs in some veins but not in all. It penetrates the quartz-sulphide filling in the form of widely scattered seams and veinslets. It is fairly abundant at the Hamburg-American, but elsewhere is in widely distributed batches or is absent. Much of the chalcopyrite exposed underground is somewhat altered to chalcocite or is encrusted with thin patches and films of malachite.

The wall rock along the fissures is in general only slightly altered. In places it is somewhat bleached and has a pale greenish color because of sorcite, but it is altered for only a few inches from the vein. Such feeble wall rock alteration contrasts strikingly with the intense alteration observed about the replacement deposits. This apparent lack of wall rock alteration is characteristic of all quartz veins in the county.

**Lead-zinc-quartz veins**

The lead-zinc-quartz veins are scattered along the north side of the Coeur d'Alene River between Medimont and Cataldo, and along the Fourth of July Canyon and tributary gulleys; but one vein was observed along the Little North Fork and another along the east margin of the Beauty Bay district. These veins are more widely distributed and are more numerous than any other kind. Their distribution is apparently governed by structural deformation as they occur near or along the zones of the major west-northwest faults, mostly in Frichard rocks.

The veins are fissure fillings and lie along faults of appreciable displacement and complex deformation. The rock alongside the fissure is generally extensively broken by prominent fractures and is also disturbed by drag folds. The veins are extremely irregular and commonly swell into chimney-like bodies and lenses as much as 16 feet thick, otherwise their thickness ranges between 1 and 4 feet. Many in addition are bordered by seams and stringers which penetrate at divergent angles into the fractured wall.

The filling is composed almost wholly of milky-white, coarsely granular quartz, which in places has scattered grains and granules of galena and sphalerite; usually scanty pyrite and in some places minor amounts of arsenopyrite, chalcopyrite, pyrrhotite, and also specular hematite. These sulphides rarely form as much as 5 per cent of the filling and are usually distributed through rather widely spaced, ill-defined shoots of small size, or are scattered along the veins as occasional grains and granules. In all of them dark colored sphalerite and galena are the most abundant sulphides, but in some arsenopyrite is locally
The specular hematite was found in only one deposit in the Little North Fork district (Rainbow No. 2) associated with a little late-stage ankerite and siderite. Pyrrhotite was found only at the Crystal Spring near Wall Peak not far north of the Coburn fault. The fissures and fractures were apparently first filled with quartz, and the sulphides were added later to parts of the filling that had been reopened by minor disturbances.

The wall rock generally shows little evidence of alteration, but along some of the more highly disturbed zones the shales of the Prichard formation have locally been changed to chlorite schist.

**Silver-quartz veins**

The Commonwealth vein in the Hayden Lake district, along the main fork of Hayden Creek, is the only example of the silver-quartz type of deposit. This vein is one of the largest and most conspicuous in the county and may be traced continuously for at least 2,000 feet by its reddish and brownish, iron-stained cropping, which in places projects as much as 50 feet above the surface and elsewhere stands as a 100-foot bluff on the mountain slope. Much of the vein is 10 to 20 feet wide but in places is somewhat wider. It is apparently aligned along one of the faults of the Pend Oreille mosaic and strikes about N. 25° E., transversely across the Wallace strata.

The vein is composed largely of white granular quartz, heavily iron-stained on the surface with here and there thin patches of mica and azurite; but below the surface the quartz is accompanied by more or less widely disseminated minute grains and granules of sulphides and is associated with variable but apparently small amounts of barite (BaSO₄). The sulphides comprise some pale brownish grains of sphalerite, some grayish grains of tetrahedrite, and some of pyrite, galena, and chalcopyrite. None of the sulphides are abundant nor widely distributed but are confined to fairly well defined shoots. Old assay records show that the shoots carried from 4 to 60 ounces of silver per ton; generally less than 1 per cent copper; less than 1 per cent lead; and usually less than 5 per cent zinc. The gold content of the ore ranged from 0.02 to 0.04 ounces per ton.

The ore shows evidence of repeated structural adjustments during the general period of deposition, and much of the filling represents deposition in broccia, first broccia of the country rock and thereafter broccia of the earlier vein minerals. During the first stage of deposition a milky-white, fairly coarse-grained quartz was left in the brecciated country rock. To it was added, during the second stage of deposition, a much more finely crystalline quartz accompanied by barite and the various fine-grained sulphides. After another period of vein brecciation, a third generation of fairly coarsely crystalline comb quartz was added to rather widely spaced fractures in the earlier filling. Because the vein was not uniformly reopened during each period of structural movement, the younger minerals are confined to well defined zones within the body of the early quartz.

**Bismuth-quartz veins**

The bismuth-quartz veins are confined to the Beauty Bay district and occur with lead-zinc-pyrrhotite deposits on the property of the Gray Wolf Mining Company. These veins lie in and cut the body of porphyritic quartz monzonite, but one vein extends into the Prichard formation. They are mostly near the margin of the stock.

Some of the veins may be traced for considerable distances, and some are reported to have been prospected up the valley slope for at least 2,000 feet. Some veins are less than 4 feet thick, others are as much as 30 feet thick.
The are composed almost wholly of white massive quartz, but in places the quartz contains small grains of galena and also small grains and irregular granules of complexly associated bismuth minerals tentatively identified as native bismuth (Bi), tetracyanate (Bi₄(No, S)₄), bismuthinite (Bi₂S₃), galenobismutite (Pb₆Bi₂S₇), alkylite (Cu₂S₂Pb₆Bi₂S₇), embleite (Ca₂S₂Bi₂S₇), wittichenite (3Cu₂S₃Bi₂S₅) accompanied by minor amounts of tetrahedrite, chalcopyrite, and jamesonite (4Pb₆, FeS₃Sb₂S₇). In much of the ore the minerals appear as grayish amorphous rather than as distinct grains and crystals. Assays of the bismuth-bearing quartz reveal a small gold and silver content.

In places the quartz filling has been invaded by the lead-zinc-pyrrhotite assemblage and it appears, therefore, that the veins are older than the sulphide replacement deposits.

Quartz veins

Quartz veins are widely scattered over the county but are most numerous in the Hayden Lake district than elsewhere. These veins occur under the same geologic conditions as do the sulphide-bearing quartz veins and differ from them only in the absence of appreciable amounts of sulphides. Some of them are less than 3 feet thick; others are as much as 40 feet thick. Some are very irregular in size and may extend from a thin seam into a chimney-like body 30 feet in diameter. Some are relatively short, but others may be traced for several thousand feet.

Most of the larger veins are entirely barren of sulphides, and are composed of milky-white, coarse-granular quartz, in part enclosing breccia fragments of altered country rock. Others have insignificant but widely scattered grains and small pods of sulphides, particularly pyrite and arsenopyrite, and less abundantly sphalerite, galena, and chalcopyrite. A few have been penetrated by minor seams of ankerite or siderite, in which may be additional small crystals of pyrite.

These veins have been prospected for gold, but assays on selected samples collected by the writer indicate a very low gold content, commonly recorded as traces.

Specularite-barite veins

One of the specularite-barite veins in the Pine Creek district appears to be along the fissure occupied by a siderite vein. Another occupies a parallel fissure a short distance away. These veins are from 3 to 14 inches thick and have been traced for several hundreds of feet without showing much change in other thicknesses or mineral content.

The fissures are largely filled with coarsely crystalline barite cut and cemented by seams of specularite associated with more or less magnetite. Some quartz is present, and the iron oxides replace and cement the fractured quartz as well as the barite and brecciated country rock. As the specularite and magnetite are younger than the barite, their presence indicates an accession of heat by the mineralizing solutions at the close of the general period of mineralization. The occurrence of thin seams of specularite in the nearby siderite deposits indicates that the barite-specularite belong to a somewhat younger stage of deposition than the siderite.

Paragenesis is

The description of the different classes of deposits indicates that the minerals were not all deposited at the same time, that deposition was repeatedly interrupted by minor disturbances, and that the ore was introduced during several pulsations of mineralizing solutions. The descriptions also bring out that there
were regional variations in the composition of the mineralizing solutions and that the composition of the solutions in any one place continued to change during the general period of mineralization. As a result, the disturbances served to introduce new mineral assemblages of different character from earlier assemblages. They also helped to bring about the formation of the group of quartz veins and the group of replacement deposits that contain very little quartz.

Quartz was always deposited first in the quartzose fissure veins; and, unless it was subsequently disturbed so that the filling was reopened, it remained barren. Where the quartz veins were fractured and made accessible for the continued flow of solutions, pyrite and chalcopyrite were added to some of the fillings. Some pyrite, sphalerite, and galena; minor amounts of arsenopyrite, chalcopyrite, and locally pyrrhotite; and complex bismuth minerals were added to a few other fillings. Some of these sulphide-bearing veins then remained permanently sealed, but others were again refraeted and variable amounts of ankerite and, locally, siderite were added. In some places the second reopening proved to be one of major importance, for in the Burnt Cabin the deposition of ankerite and then siderite acted to replace much of the earlier quartz filling with its associated, scant pyrite-chalcopyrite assemblage, whereas at the Riverside the deposition of siderite and a succeeding base-metal assemblage largely removed an earlier copper-quartz filling. At the Gray Wolf, reopening of some of the bismuth-quartz veins permitted the introduction of minor amounts of lead-zinc-pyrrhotite ore.

The disturbances, however, not only reopened the quartz veins but produced many entirely new fracture zones in the previously unmineralized country rock. Such new fracture zones in the Beauty Bay area were invaded by the base-metal assemblage of pyrite, arsenopyrite, sphalerite, pyrrhotite, and galena, which apparently underwent little disturbance during their period of deposition. At the Palisades, the fracture zones received siderite, scant pyrite and arsenopyrite, and locally barite, but were not reopened in time to receive appreciable amounts of sphalerite and galena. Marked refraeting did occur, however, at the Riverside, where the siderite and earlier quartz received further additions of base-metal sulphides, namely, some pyrite, much sphalerite, minor amounts of tetrahedrite, and considerable galena, the dopositional sequence slightly interrupted by minor structural adjustments.

Many of the deposits were also affected by still another general period of reopening. specular hematite and minor amounts of druzy quartz and pyrite were added to the carbonate filling at the Burnt Cabin. Specular hematite and magnetite were added to the siderite and barite filling at the Palisades, and minor amounts of specular hematite and pyrite were added to the Rainbow lead-zinc-quartz vein in the Little North Fork district. Many other veins also received late additions of quartz; some too of a little pyrite and arsenopyrite.

None of the deposits fail to record two or more of the above stages of mineralizations. The Commonwealth shows evidence of three stages of quartz deposition, each under somewhat different physiochemical conditions. The earliest quartz is barren of sulphides, except where broeicated and healed or partly replaced by a second-stage quartz which is associated with barite and minor amounts of sulphides. Where these second-stage minerals become broeicated, minor amounts of comb quartz were added to the filling.

**GENESIS OF THE DEPOSITS**

**Source of the ore**

The distribution of the deposits along the axis and flanks of a much faulted anticlinial uplift, the growth of which was accompanied or closely followed by an invasion of igneous magma, implies a close relation between folding, faulting,
igneous intrusion, and mineral deposition. The deposits are mostly contained along the principal fracture zones, not in the main fractures, however, but in subordinate fissures and adjoining shattered rock in which there was little gouge to impede the movement of the mineralizing solutions. Reverse faults, perhaps formed by lifting forces, have apparently been most effective in providing channels for movement of the ore-bearing solutions and the deposition of ore. As much of the faulting took place during the general period of magmatic activity, the lifting forces as well as those of collapse might reasonably be credited to adjustments in the underlying magma body. Many of the deposits are near intrusive rocks or in areas where the sedimentary strata show evidence of igneous metamorphism, and some are cut by the youngest of the basic dikes. From these facts and because movement along faults was obviously recurrent during the general period of mineralization, it may be inferred that the underlying magma provided a source for the ore-bearing solutions. Such a magmatic source is also inferred for the ore in the Coeur d'Alene district.

Character of the ore-bearing solutions

During the earliest stages of mineralization, the ore-bearing fluids were highly siliceous and deposited mainly quartz and later, minor amounts of sulphides and, in places, carbonates. These solutions apparently had no great penetrating power but mainly occupied the available fissures, filling them with vein materials, notably quartz. The solutions had little effect on the wall rock and, because of their inability to replace and appreciably alter the country rock, were probably not highly heated or under excessive pressure but were more than likely hydrothermal solutions of mesothermal character.

After the deposition of the quartzose ore, however, there was a more or less abrupt change in the composition of the solutions, forewarned perhaps by the late deposition of carbonates. This abrupt change in composition accompanied more or less closely marked structural adjustments, which not only faulted the quartz fillings but also created new fissures and fracture zones, which were in general more effective in guiding the younger solutions than were the reopened quartz veins.

In contrast to the earlier solutions, the later were not particularly quartzose but apparently carried mostly metals. In addition, the solutions had great penetrating power, replaced earlier fillings and the rocks bordering the fissure and fracture zones, and altered the wall rock extensively. In the Beauty Bay and Roundtop districts, the solutions were highly heated and permeated the fracture zones, forming high-temperature siliciclas in the wall rock and replacing considerable of the intensely altered rock by sulphides, particularly by pyrrhotite and arsenopyrite. The presence and abundance of pyrrhotite and arsenopyrite also indicate that the temperature of the solutions was high and that the deposits belong to the hypothermal class, that is, those formed at high temperature and at considerable depth in association with intrusive igneous rocks and presumably not far from their magmatic source. In other places, the solutions were further removed from their magmatic source, and deposition took place under mesothermal conditions, that is, under more moderate conditions of temperature. Such deposition was accompanied by rather intense sericitization of the country rock, and the ore was deposited by replacement, in part in reopened quartz veins, in part in new fissure and fracture zones.

Another marked change in the composition of the ore-bearing solutions is recorded in three of the deposits, each of which shows evidence of a major reopening after the siderite (locally barite) stage. During this stage, the solutions deposited specular hematite and minor amounts of magnettite (together with pyrite in

\[\text{Ramsay, F. L., and Galtins, F. C.}, \text{The geology and ore deposits of the Coeur d'Alene district, Idaho}^*; \text{U. S. Geol. Survey Prof. Paper 62, p. 135, 1908.}\]
ZONING OF DEPOSITS

The distribution of the deposits, particularly the replacement deposits, reveals some evidence of zoning. The deposits with high-temperature characteristics are mostly grouped along the more central parts of the anticlinal structure and are most abundantly developed, as in the Beauty Bay district, in the vicinity of intrusive rocks. The Rainbow vein at the head of Evans Creek is far from the crest of the arch; but, on the other hand, it is not far from a center of igneous activity. The deposits with mesothermal characteristics, on the contrary, are along the flanks of the arch, particularly along the zone of the Burnt Cabin fault, and are considerably to one side of zones of intrusive igneous rocks. These relations suggest a zoning of the ore deposits with respect to the principal area of igneous activity which closely accords with the more central parts of the broad antiplane. Deposits near the zone of igneous intrusion are therefore typically hypothermal, whereas those farther removed have mesothermal characteristics.

OUTLOOK

Mineral deposits are rather widely distributed over Kootenai County, but not one of them has produced much ore. The quartz veins are most widely scattered and have been more extensively prospected than the group of replacement deposits, but only minor amounts of sulphides have been found in them and not enough to afford any sustained commercial production. Because of the scant distribution of their sulphides, these veins are not likely to play any important role in the mineral industry of the county and can not be looked upon as a favorable source for copper, lead, and zinc. If gold is contained in them, it appears to be too widely and irregularly distributed to be extracted profitably.

The high-temperature lead-zinc-pyrrhotite deposits contain much massive ore in bodies of considerable size; but, unfortunately, the most abundant ore minerals are pyrrhotite and arsenopyrite, and the valuable minerals, galena and sphalerite, are confined to relatively small pockets and shoots which so far have not been large enough to be of commercial interest. These deposits have apparently been considerably eroded and their present form suggests that perhaps the ore of highest grade has already been lost. Because of mineralogical and structural relations of these deposits, no improvement in the grade of ore need be expected with additional depth. At best, the tonnage may remain about the same as that found on present levels.

The lead-zinc-siderite type of deposit appears to offer the most encouragement, although only one body has so far been uncovered. The exposed body is relatively small, but prospecting up through 1937 had not disclosed enough of the lode to determine its limits. The character and structural relations of the ore are the same as in those deposits that have produced the bulk of the ore in the Coeur d'Alene mining district. As these deposits have inconspicuous outcrops and

\[\text{Burbank, W. S., } \text{A source of heat-energy in crystallization of granodiorite magma and some related problems of volcanism, Amer. Geophysical Union, Tr., pt. 1, pp. 236-265, 1936.}\]
may be entirely concealed by overburden and brush, they are not easily found and it is not improbable that careful search may disclose others.

Structural features of Kootenai County are not much different from those of Shoshone County and, in fact, are in a considerable part an extension of those of Shoshone County. Most of the mineral deposits in both counties are along a broad but much faulted anticlinal arch of general west northwest trend, not far from longitudinal faults of large magnitude which have broken the arch. Such faults as the Osburn, Placer Creek, and Burnt Cabin, therefore, extend into or across both counties; and here and there subordinate faults in their vicinity have guided mineral-bearing solutions and contain ore. Igneous intrusion has been localized along more central parts of the arch with special centers in the Coeur d'Alene district and at Beauty and Wolf Lodge bays. The composition of the intrusive rocks, however, differs for whereas the diabasic and lamprophyric rocks are distributed throughout the length of the arch, the rhyolite and granite porphyries and some of the closely allied rocks have been recognized only in the Beauty Bay and Wolf Lodge Bay area, and coarse-grained monzonite and syenite, only in the Coeur d'Alene district. Most of the ore deposits appear to favor areas in which igneous intrusion has been rather strongly manifested and to favor steeply dipping reverse faults, along or near zones of rather intense deformation.

There is little difference in the mineral composition and in the mineral paragenesis of the veins in the two counties. This is true particularly of the lead-zinc-siderite deposits, for the ore at the Riverside mine is indistinguishable in its composition and occurrence from the lead-zinc-siderite ores of the Coeur d'Alene district. The lead-zinc-pyrhotite ores on the other hand resemble the lead-zinc deposits in the Pine Creek district west of Kellogg, \(^\text{2}\), and to some extent the deposits in shear zones in the Murray district in the region north of Wallace \(^\text{2}\). In both localities, pyrhotite forms an appreciable part of the ore and there is little essential difference in structural and textural characteristics. Pyrhotite and arsenopyrite, however, do not appear to be quite so abundant as in the Beauty Bay district, and there is some reason to believe that the ore deposits at Beauty Bay represent a more intense phase of mineralization than do the Pine Creek or Murray deposits. As pyrhotite appears at depth in many of the Coeur d'Alene lead-zinc-siderite deposits and as its presence generally has been taken to indicate the downward limit of ore of commercial grade, it is possible that the lead-zinc-pyrhotite deposits in Kootenai County are the equivalent of the lower parts of the typical lead-zinc-siderite deposits of the Coeur d'Alene district. Except for the absence of the tungsten mineral, scheelite, and the presence of only nominal amounts of gold, the quartz veins of Kootenai County show marked resemblance to the quartz veins in the Murray district. \(^\text{3}\) This resemblance is not only mineralogic but also structural and textural. As in Kootenai County, the sulphides, which include galena, sphalerite, chalcopyrite, pyrite, arsenopyrite, ankerite, and specularite, rarely make up more than 5 per cent of the ore. The remainder is quartz.

So far as structural features are concerned, Kootenai County seems as favorable to the occurrence of large mineral deposits as does Shoshone County; but the commercial value of the deposits in Kootenai County has been found to be very small. Perhaps the reason for the dearth of commercial deposits in Kootenai County is that the zinc-lead stage of ore deposition was in general rather weak, which may account for the discovery of only one lead-zinc-siderite deposit. Aside

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\(^{3}\) Shannon, F. J., Idaho, pp. 10-21. 47
from the quartz veins, the lead-zinc-pyrrhotite deposits are the most characteristic of the county. These are much like the deposits at Pine Creek, which have not been nearly so productive as the lead-zinc-siderite deposits in the main part of the Coeur d'Alene district. They may represent the type of deposit into which the Coeur d'Alene ores pass in depth. If so, they represent the roots of deposits that formerly extended above the present erosion surface. It is evident from the kinds of minerals present, and from the character of the wall rock alteration, that the deposits at Beauty Bay and on Evans Creek were formed at distinctly higher temperature than the commercial lead-zinc deposits of the Coeur d'Alene district, and it is probable that they have been much more deeply eroded. Were the gold and tungsten present in much lesser amounts in the Murray district, the quartz veins there would be no more productive than those in Kootenai County. Unless the quartz veins in Kootenai County should disclose a notable gold content, they can not be expected to prove of commercial value. Such veins apparently do not yield large amounts of lead or zinc.

The most favorable areas for prospecting in Kootenai County are probably on the flanks of the broad arch along the general zones of the large faults of west northwest trend. The zone along the Burnt Cabin fault should offer the most attractive inducements to the prospector, because such deposits as have been found have features which reveal that they have been formed under conditions of moderate temperature and pressure and that they have not been so deeply eroded as those along the more central part of the arch in the vicinity of exposed intrusive rocks. Search should be made where the rocks have been bleached by the action of hydrothermal solutions and more or less thoroughly sericitized.

DESCRIPTION OF PROPERTIES

LEAD-ZINC-PYRRHOTITE DEPOSITS

Caribou

The Caribou group comprises 10 unpatented claims on Beauty Creek about 1.3 miles from U. S. Highway 95-E, and is in sections 12 and 13, T. 49 N., R. 3 W. It is owned by the Caribou Mining Company, incorporated July 5, 1918, and has approximately 1,700 feet of workings, principally in the No. 2 and No. 3 tunnels (fig. 2.) The property also has a 50-ton, gas-driven, flotation concentrator owned by the Coeur d'Alene-Beauty Bay Mining and Milling Company, which had been erected to treat all the ore of the Beauty Bay district. The mill was completed in 1931, but both mill and mine have since been idle.

The Caribou property covers the margin of the quartz monzonite stock and the tunnels are driven partly in granite rock and partly in altered quartzite of the Frichard formation. Several mineralized zones are known on the property, but only one has been explored in the two upper levels; and, although two somewhat mineralized zones were uncovered in No. 3, it is not wholly certain that either one is a continuation of the body on the levels above. The veins have a general northerly trend, but curve widely and, when traced to the north, change strike from northwest to northeast. Their dip is east at steep angles. In places, the fracturing and mineralization appear to follow the quartz monzonite-quartzite contact.

In the No. 1 (upper) tunnel the vein has been opened for 80 feet with the ore in part stoped to the surface. The vein strikes N. 80° W. and dips 60° E., and here and there shows 18 inches of sulphides. The No. 2 level is only 30 feet below, but has exposed the vein for a considerably greater distance. The vein is somewhat disturbed near the portal but appears to be 2 to 3 feet thick and to strike N. 28° E. In about 50 feet, however, the strike changes to due south and
Figure 2. Geologic sketch map of the underground workings at the Caribou property. Bedrock is Prichard formation and quartz monzonite. Strike and dip of bedding shown by symbols.
near the face to southeast and again to southwest. The body is from 2-1/2 to 3 feet thick, but swells to 6 feet. Much of it consists of massive sulphides, but the ore minerals are rather erratically distributed. In some places, granitic rock forms the footwall, but much of the vein is in quartzite. The detailed geologic relations are given in Figure 2.

The No. 3 tunnel is near creek level, 180 feet below the No. 2. Along it the geologic relations are much more complex than on the upper levels. The first 66 feet of the tunnel is through quartz monzonite; the remainder through quartzite, but in part along the contact of quartz monzonite. In the west fork, the tunnel shows some masses of micaceous quartzite in addition to the quartz monzonite and some minor slips containing sulphides. The drift is along, or close to, the igneous contact but lies mostly in the granitic rock on a minor contact fissure. Some of the sulphide seams and lenses are 2 to 8 inches thick but rarely as much as 12 inches thick. The mineralized zone reaches 2 feet as a maximum (fig. 2). This vein strikes about N. 30° E. and dips 68° S.E. The east fork of the tunnel passes through the quartz monzonite body and discloses another mineralized zone in quartzite, again here and there along the contact of quartz monzonite apophyses. The fracturing is rather prominent through a zone 4 to 5 feet wide; but the ore is scattered through it in small bunches. In one place, however, there is a massive sulphide body 3 feet thick.

Much of the sulphide on the No. 3 level consists of pyrrhotite grains and masses, and all ore mined has come from the two upper levels. Above the No. 5, the ore contains considerable arsenopyrite in addition to pyrrhotite, and has scattered bunches of galena and sphalerite. Minor amounts of chalcopyrite and quartz are also associated with the ore. The wall rock has been somewhat sericitized and also slightly silicified. In places, the altered rock contains considerable chlorite.

Gray Wolf

The Gray Wolf group comprises 9 unpatented claims on Beauty Creek about 1.8 miles from Beauty Bay. It is owned by the Gray Wolf Mining Company, incorporated May 18, 1917, and has been developed by one main tunnel with about 990 feet of workings (fig. 3) and by several short tunnels, each on separate veins. This property was active in 1921, 1924, and 1929.

The property lies at the margin of the porphyritic quartz monzonite stock, and has veins cutting both the stock and the quartzite. It has both lead-zinc-pyrrhotite replacement deposits and bismuth-quartz veins, the replacement deposits occurring in the quartzites, the bismuth-quartz veins appearing close by and mostly in the granitic stock. The lead-zinc-pyrrhotite deposits strike about due north and dip steeply west. They occur along extensively altered fracture zones many feet wide, but the more massive sulphide zones are but 2 to 4 feet wide. The bismuth-quartz veins on the other hand strike N. 20° E. to N. 60° E., and occupy an entirely different set of fractures. Some of the quartz veins are as much as 30 feet wide.

The main workings are on the south side of the creek, where an adit has been driven along a large bismuth-quartz vein for 250 feet and then turned to intersect a lead-zinc-pyrrhotite body about 140 feet to the west (fig. 3). The bismuth-quartz vein strikes about N. 60° E. and is as much as 30 feet thick. Its extension across the creek has been prospected by a 20-foot tunnel and the vein has been traced up the slope to the summit of the ridge. This vein is in the quartz monzonite north of the creek, but in the adit it cuts and replaces altered brecciated quartzite of the Prichard formation. In places, the quartz contains wided scattered crystals and grains of bismuth minerals, and here and there small
Figure 3. Sketch map of the underground workings at the Gray Wolf property. Bedrock is Prichard formation. Strike and dip of bedding shown by symbols.
and scattered grains of pyrrhotite, sphalerite, and galena, introduced during a later stage of metallization. The vein is cut by two basic dikes (lamprophyric) where exposed in the adit (fig. 3).

The lead-zinc-pyrrhotite vein has been drifted on for 285 feet. Its strike is about N. 50° E. and dip 75° E. It occupies a relatively narrow zone of fracturing, generally from 2 to 4 feet wide, in which are scattered seams and bands of sulphides 2 to 10 inches thick. In parts of the fracture zone the quartzite is considerably crushed but is only slightly altered and mineralized. Some parts of the zone has thin quartz seams with a little associated sulphide.

Other explored veins lie in the stock north of the creek. These are bismuth-quartz veins which range from 4 to 15 feet wide and are reported to extend up the slope for 2,000 feet. One has been opened by a 45-foot shaft; another by a 60-foot tunnel. There is also a 100-foot tunnel. These veins contain some bismuth minerals and minor amounts of galena. It is reported that the amount of sulphide declines with increasing distance from the margin of the stock.

The lead-zinc-pyrrhotite deposits contain mostly pyrrhotite, but there are places where sphalerite and galena become fairly conspicuous and where pyrite, chalcopyrite, arsenopyrite, quartz, and calcite may be recognized. The bismuth-quartz veins may also contain scattered scant amounts of younger pyrrhotite, sphalerite, and galena. The bismuth minerals tentatively identified include tetradymite, native bismuth, aikinite, empeticite, bismuthinite, wittichenite, galenobismutite associated with scant jamesonite (?), chalcopyrite, and tetrahedrite.

Silver Tip

The Silver Tip group comprises 16 unpatented claims on Varnum Creek, a short distance above its junction with Beauty Creek in Sec. 16, T. 49 N., R. 2 W. It is owned by the Silver Tip Mining Association and is one of the more extensively developed properties in the Beauty Bay district. The development consists of two main tunnels on opposite sides of the creek (fig. 4) in one of which an inclined shaft on the ore has been sunk to a depth of 125 feet. The property was more or less continuously active from 1926 to 1931 but since 1931 has been idle. Some ore was stoped during its period of activity and treated at the custom mill on the Caribou property.

The claims cover several mineralized fracture zones of general northerly trend, but only two of them have been explored underground. These fracture zones cut the rather highly metamorphosed impure quartzites of the Priehard formation in the vicinity of several long, narrow rhyolite and granite porphyry dikes. The deposits are typical of the lead-zinc-pyrrhotite replacement bodies in the Beauty Bay district and occur along fracture zones of considerable width and persistence, although the width of the more highly mineralized parts rarely exceeds 6 feet. The principal body, the Silver Tip, strikes about N. 50° W. The Black Bear vein about 200 yards down stream has a similar strike, but one a short distance up stream from the Silver Tip strikes about N. 10° to 15° E. Each of them shows considerable curvature along the strike. Their dip is steeply west.

The Silver Tip has been explored by an adit drift on the south side of the creek (fig. 4) for a distance of about 210 feet, and to a depth of 125 feet from the drift level by an inclined shaft in 125 feet from the portal. On the drift level the vein dips 30° to 35° W., but steepens with depth, the incline passing into the hanging wall 65 feet below. The vein is from 3-1/2 to 4 feet thick from the portal to the shaft; but near the shaft the thickness increases to 5 feet and a few feet beyond to 10 feet. It decreases to 4 feet, however, near the face.
Figure 3. Sketch map of the underground workings at the Gray Wolf property. Bedrock is Prichard formation. Strike and dip of bedding shown by symbols.
The hanging wall of the vein is prominent but the footwall is ill-defined. The entire ore body is rather heavily mineralized with pyrrhotite, in places as scattered bunches, in others as narrow bands. Sphalerite and galena are found in appreciable quantity only near the inclined shaft in a short perhaps less than 50 feet in stop length. Since the incline was filled with water, relations below could not be determined.

A crosscut from the face of the Silver Tip drift exposed the second mineralized body 50 feet to the east. At this point, the second vein is about 3 feet thick, strikes slightly west of north, and dips 60° W. (Fig. 4). It is composed largely of massive pyrrhotite. The same mineralized fracture zone is explored more extensively by adit drift on the north side of the creek (Fig. 4), where it appears to be as much as 8 feet thick for the first 100 feet but narrows to about 3 feet the second hundred and then passes into the wall or appears along the drift with scattered, thin seams and nests of sulphides. It has considerable pyrrhotite over the portal, but the sulphide content decreases very considerably away from the portal, and much of the tunnel is through barren rock. North of the creek the vein changes its strike from north to northeast.

The Black Bear body is exposed in two short tunnels on each side of the creek. The vein is 3 to 4 feet thick and contains some lead and zinc in addition to considerable pyrrhotite.

Some of the ore mined on the property remains on the dump and in the ore bin below. This ore consists largely of massive sulphides shading into the altered country rock and is made up mostly of pyrrhotite, somewhat lesser amounts of pyrite and arsenopyrite, and smaller but variable amounts of sphalerite and galena. Some of the galena appears as clean veinlets cutting the other sulphides. The arsenopyrite is present in two generations, the second with a little later druse quartz. Thin sections show that the country rock has been rather thoroughly sericitized, and then cut and replaced by sulphides or by quartz and sulphides together.

Johnny Mack

The Johnny Mack property is in the Beauty Bay district on the North Fork of Varnum Creek about 1-1/2 miles above the Silver Tip in Sec. 17, T. 49 N., R. 2 W. It has been developed by an adit about 250 feet long and by several small cuts. The property has made no shipments, but has several tons of massive sulphide ore on the dump.

The adit is in quartzite and slate of the Prichard and extends into a body of porphyritic granite. It exposes a mineralized zone about 150 feet long which, for about 40 feet, has 3 to 4 feet of massive sulphide ore. This body strikes about N. 50° E., and dips steeply west. It is a replacement of the Prichard along a minor zone of fracturing 1 to 5 feet wide. The ore exposed on the dump is mostly pyrrhotite and galena; but there is a little chalcopyrite and ankerite as well as scant amounts of pyrite, sphalerite, and quartz. The sulphides, which are massive and fairly coarse, cut and partly replace the ankerite. The ore is partly banded because of the presence of thin parallel seams of galena extending through the massive pyrrhotite.

Wilson Mutual

The Wilson Mutual Mining and Milling Company has four groups of claims in the vicinity of Wel' Lodge Bay. The part of the property examined is along the lake shore in Sec. 1, T. 40 N., R. 3 W., and has on it several mineralized zones which form conspicuous, somewhat iron-stained lodes of considerable size. Two
tunnels have been driven into the ridge from the level of the highway (U.S. 95E.e), but only the longer one is open. The one with blocked portal apparently been driven to explore a mineralized zone about 50 feet wide where it is exposed in the highway cut beneath a deep overburden. The exposed part is limonite-stained and has impregnated Frichard formation above, which is a fairly conspicuous gossan cap. Because of the deep overburden the trend of the body could not be determined. The open tunnel lies a short distance to the west. It is about 300 feet long and has apparently been driven through a prominent fault zone into less disturbed rock beyond which is cut by some scattered slips and small breccia zones of N. 45° to 60° W., strike and S.E. to 70° N.W. dip. Some grains of pyrrhotite were observed here and there in the quartzite, but otherwise no defined mineral zone was observed.

A second large cropping is cut by the highway about 50 yards west of the tunnel portal. The zone of altered Frichard is not less than 50 feet across and may extend 120 feet. The main part is conspicuously iron-stained by both reddish and brownish iron oxide. The staining is accentuated along slips and the more extensively fractured country rock. This body strikes N. 30° E. and dips almost vertically. No unoxidized sulphides appear in the outcrop, which is similar to that of the pyrrhotite bodies along Beauty Creek.

Rainbow No. 5

The Rainbow No. 5 group of the Rainbow Mining and Milling Company, Ltd., is at the head of Evans Creek, for the most part in Benewah County although some of the claims extend across the line into Kootenai County. This company was incorporated June 20, 1907, but has had its capital structure changed a number of times. In addition to the Rainbow No. 3 group, it also owns the Rainbow No. 4, a short distance to the north; the Rainbow No. 2 near the Little North Fork of the Coeur d'Alene River; and the Rainbow No. 1 in Shoshone County. Most of the Rainbow No. 3 group is in Sec. 20, T. 47 N., R. 1 W., nearly at the top of the mountain. The property comprises 14 patented and 5 unpatented claims on which are more than 4,000 feet of tunnels and 3,000 feet of diamond drill holes. More than half the stock of the adjoining Butte Mining Company has also been acquired and may serve to increase the No. 3 group holdings by an additional 6 patented and 5 unpatented claims. The property has a 135-foot tunnel just beneath the outcrop, about 400 feet west of the portal of a 300-foot tunnel on the Butte property. The main development is from a 2,450-foot crosscut nearly 1,800 feet below the highest part of the outcrop and in the drifts which have continued to the southeast for nearly 1,800 feet. The Rainbow No. 4 was not visited, but it consists of 4 patented claims and has 600 feet of tunnels. The company has been actively engaged since about 1930 in developing its No. 5 property.

The development has been confined to a single huge lode which extends across both the Rainbow and Butte properties in a general west-northwest direction. It appears to follow a broad crush zone in which the impure quartzitic beds of the Frichard formation have been more or less extensively cracked or shattered, and then intensely altered by mineralizing solutions which also left ore substance in the fractures. The zone of alteration is as much as 200 feet wide but is not uniformly mineralized. The quartzite is dark gray where not so intensely altered, but its original quartz grains have been partly replaced by sericite and by both chlorite and small clusters of biotite grains. In the more highly altered parts, the sericite grains increase in size and in abundance; and the biotite clusters enlarge to form single crystals. Chlorite also increases in abundance and grains of pyrrhotite appear. In the most intensely altered parts of the zone the color of the rock lightens; the sericite, biotite, and chlorite disappear; and their places are taken by quartz and carbonates and increased amounts of pyrrhotite. Because of the presence of numerous small flecks of biotite, the rock along the
bread fracture zone has an appearance of igneous rock, but in the more intensely altered part resembles a silicified quartzite.

Sulphides are not uniformly distributed through the altered zone, but appear in small bodies or shoots. These sulphides include pyrrhotite, sphalerite, arsenopyrite, pyrite, galena, and a little chalcopyrite, associated with scant amounts of ankerite, calcite, and quartz. The sulphides are generally fine-grained and occur as thin seams and veinlets in the fractured and brecciated country rock, as fillings of fractures, and as a replacement of the silicified quartzite. Pyrrhotite is most widespread but other sulphides, except chalcopyrite, may be locally abundant. These occur mainly as granules and small pods in massive pyrrhotite. The calcrite is younger than the sulphides; the ankerite, older. The upper tunnel has been driven into but not through the altered zone and shows considerable pyrrhotite and arsenopyrite. The Butte tunnel across the gulch exposes in places considerable sphalerite and galena as well as pyrrhotite. It is reported by the management that 33 feet of milling ore were disclosed at depth by diamond drilling and that analyses of the drill core indicated 11.16 per cent lead and 8 ounces of silver per ton. This showing prompted the company to undertake deep development.

ARSENOOPYRITE DEPOSITS

Beauty Bay

The Beauty Bay property is on the ridge separating Beauty Bay from Wolf Lodge Bay, north and northeast of the mouth of Beauty Creek in sections 1 and 12, T. 46 N., R. 3 W. It is owned by the Beauty Bay Mining Company and the property includes the Beauty Bay group of 3 unpatented claims on which are several shallow shafts, 5 short tunnels, and a number of shallow cuts. Some work was done in the early twenties, but since then only the required annual labor has been done.

The group covers a number of veins or zones of mineralized rock, most of which are in altered Friisbad formation; but some of which are in a pre-Cambrian diorite sill which trends northeast across the ridge. The surface relations are not wholly clear and the apparent large number of veins may represent duplication by faulting. Many of the veins are short and have a staggered relation. The bodies are irregular as to size and distribution but are alike in that arsenopyrite is their predominant mineral. Galena is reported and a little pyrite, pyrrhotite, chalcopyrite, and galena were found in some of the specimens on one of the dumps.

A shaft about 45 feet deep on top of the ridge above Beauty Bay explores a body which trends N. 30° W., and dips 86° S.W. The body is from 3 to 4 feet thick and consists of somewhat fractured and iron-stained quartzite between well-defined walls. A second shaft of equal size is about 150 yards to the east and is on another vein, which, from the alignment of open cuts, strikes N. 60° E., and dips 80° N.W. This vein is about 3 feet thick and consists largely of quartz with some arsenopyrite and galena. Further east are other cuts and caved tunnels on quartz-arsenopyrite bodies, some of which strike N. 60° E. and dip 80° N.W. Some of these are as much as 16 feet thick. The most easterly body is the largest and strikes N. 45° W. The mineralized zone is 16 feet across, but is chimney-like and contains massive arsenopyrite in bunches and pockets along with some quartz and pyrite in brecciated quartzite. This body can be traced for about 100 feet.

Coeur d'Alene Mountain

The Coeur d'Alene Mountain property is more the head of Beauty Bay at lake level. It is owned by the Coeur d'Alene Mining Company, incorporated May 29, 1929,
and consists of 7 unpatented claims on which is an adit with about 210 feet of workings. The adit is driven along a somewhat mineralized fault zone for about 60 feet and then turns aside and passes diagonally through the country rock for 50 feet where it branches, each branch extending on for an additional 50 feet. The fault strikes about N. 45° W., and dips very steeply northeast. It cuts the bedding of the Frischard formation, which locally strikes about N. 45° W., but dips vertically to steeply southeast. Drag associated with the faulting indicates a reverse movement. The fault zone has been somewhat impregnated with arsenopyrite and the rock altered hydrothermally. The average thickness of the altered zone is about 3 feet.

**Blue Bird**

The Blue Bird property is in the Beauty Bay district on the upper south slope of Elk Mountain in Sec. 17, T. 49 N., R. 2 W. It is owned by the Blue Bird Mining Company, incorporated September 2, 1924, and comprises the Blue Bird group of 9 unpatented claims. It has a 65-foot shaft on the crest of the ridge and a tunnel about 100 feet long on the slope about 150 feet below. Some other cuts and short tunnels, as well as the shaft, are inaccessible. The mineralized body was not cut by the tunnel and is not well exposed on the surface. It apparently trends in a westerly direction and dips steeply north. It is reported to be as much as 30 feet thick and to contain considerable galena at the bottom of the shaft. Such sulphides as remain on the dump at the shaft consist wholly of arsenopyrite associated with a little quartz.

**LEAD-ZINC-SIDERITE DEPOSITS**

**Riverside**

The Riverside property is on the Little North Fork about a mile below the mouth of Beckjack Creek in Sec. 25, T. 51 N., R. 1 W. It is owned by the Riverside Copper Mining Company, incorporated September 17, 1906, and consists of 5 patented claims on which is a tunnel about 500 feet long. The property has been generally inactive for many years, but work was revived during 1937 and the property made ready for extensive development. Sills were erected in which to store lead-zinc ore uncovered in development and a station was cut underground preparatory to sinking a shaft.

Several veins are exposed on the property; but present work is confined to one, a lead-zinc-siderite replacement deposit in extensively sheared and altered Wallace formation. The other veins, one of which is exposed by a drift a short distance from the portal of the crosscut, are typical copper-quartz veins.

The Wallace is represented by the black, limy shales and argillites which locally have almost a vertical dip. In the crosscut the dark color is lost and the rock instead is bleached to a pale greenish-gray color. The rock is greatly disturbed through the bleached zone, showing increased fracturing and very prominent fracture cleavage toward the lead-zinc deposit. The bleached zone is as much as 300 feet wide and the lead-zinc deposit is confined to the most intensively deformed and altered part of the zone. The structural relations are indicated on the geologic sketch map, Figure 8. The ore body strikes about N. 30° W., and dips 75° to 78° N.E. It is as much as 5 and 6 feet wide and 40 feet long, composed of extensively chattered and sheared rock replaced by soams, bands, and irregular small bunches of ore. The copper vein near the portal is along a fissure bounded by little fractured and altered rock and strikes about N. 45° W., and dips more steeply northeast (82°) than does the lead-zinc deposit. The copper vein is from 1 to 2 feet thick but at the face of the drift is 8 feet.
Figure 5. Geologic sketch map of the underground workings at the Riverside property. Bedrock is Wallace formation. Strike and dip of bedding shown by symbols.

Figure 6. Sketch map of the accessible lower workings of the Palisade property. Bedrock is Burke formation. Strike and dip of bedding shown by symbols.
Figure 7. Geologic sketch map of the underground workings at the Shamrock property. Bedrock is Wallace formation. Strike and dip of bedding shown by symbols.

Figure 8. Sketch map of the levels on the Burnt Cabin property. Bedrock is St. Regis formation. Strike and dip of bedding shown by symbols.
The lead-zinc deposit is associated with quartz and siderite of which siderite is most abundant. The principal ore minerals are galena and sphalerite but there are minor amounts of chalcopyrite, bournonite, and pyrite. The siderite is brown, finely granular; the galena is fairly coarse. Both replace siderite and quartz, some of the galena in beds 1 to 2 inches thick. Most of the sulphides are in nests and bouchons or enclose a breccia of altered fragments of country rock. The amount of galena and sphalerite apparently exceeded all gangue and other metallic minerals combined. The copper vein, on the other hand, is composed largely of milky-white quartz in which are widely scattered grains and granules of chalcopyrite, in part crusted by malachite.

The bleaching of the rock has been accompanied by the formation of sericite and, as the intensity of bleaching has increased, so has the amount of sericite. In the less highly altered beds much original carbonate is retained, but as the alteration increases the amount of carbonate proportionately decreases, its place being taken by more sericite. In the most intensely deformed and altered zone along the ore body, the sericite has been largely destroyed because of the position of quartz.

SIDERITE DEPOSITS

Palisade

The property of the Palisade Mining and Milling Company is in the extreme southeast corner of Routt County near the summit of Elgin Crags at the head of a branch of Pine Creek in Sec. 6, T. 47, N., R. 1, E. It is reached by road from Pine Creek. The company was incorporated January 31, 1912, and the property consists of 24 unpatented claims on which are several tunnels aggregating nearly 2,000 feet of workings. This property has been active at different times and considerable development has been done since 1885. A road to the property was completed in 1936. In 1927 the mine plant was destroyed by a snowslide and the lowest tunnel, a crosscut about 1,100 feet long, was abandoned partly because of snowslides and partly because development could continue to better advantage from a point a short distance away.

This property is in an area of quartzitic rocks belonging to the Burko formation, the beds of which strike about N. 80° E. and dip 25° to 30° S.E. Otherwise the strata have not been much disturbed. The beds have been cut by several veins which have been explored near and on the outcrop at the crest of the mountain and in some tunnels several hundred feet below. These veins show a marked change in mineralogy along the strike and with increasing depth. At the outcrop they contain barite, specularite, magnetite, and a little quartz. Farther down the slope they are composed of massive siderite.

Two barite-specularite-magnetite veins are exposed in a 64-foot incline on the dip of the strata near the crest of the ridge. The one exposed in the bottom of the incline has from 12 to 14 inches of specularite, quartz, and barite, and strikes N. 75° W., and dips 73° N.E. The second about half way up the incline strikes N. 80° W., but dips northeast at the same angle as the other. It has about 8 inches of barite and iron oxides. Both have been offset slightly by nearby flat faults. In a cut above the incline one of the veins has 12 inches of barite and some crystals of specularite. Other cuts trace these veins down the slope toward the main workings where the filling is siderite. The barite forms fairly coarse crystals (some as large as 1 by 3/4 inches) and loosely textured crystalline aggregates cut and cemented by specularite and magnetite, the specularite commonly in fairly coarse plates. The wall rock appears to be little altered.

The main siderite vein on the slope below the specularite-barite cropping
strikes about N. 80° W. and dips about 76° N.E. It is accompanied by a number of
gash veins which extend outward at oblique angles to the west-southwest for dis-
tances of 60 to 80 feet. The main vein and two of the laterals are shown in Figure
6. These veins are very irregular as to size and in places swell abruptly into
large chimney-like masses. The main vein is but 1 to 2 feet thick for some dis-
tance from the portal and consists wholly of massive siderite, containing some
scattered grains of pyrite and arsenopyrite and holding in places small bunches of
quartz. Well in from the portal its thickness increases to 5 feet of massive sid-
erite, but within a short distance it is cut by a lamprophyre dike (strike N. 120°
W., dip 74° S.W.), and from there on its thickness is but 2 feet. In one of the
laterals the siderite vein is about 2 feet thick for about 60 feet and then pinch-
offs out just beyond the intersection with a 1-foot lamprophyre dike. In another
the vein swells into a chimney about 10 feet in diameter, but again pinches beyond
a 2-foot lamprophyre, and is but 1 foot thick in the face where its strike is S.
80° W. and dip 76° N.W.

These siderite veins have replaced the quartzitic country rock. Occasional
granules of galena have been reported. In one place, the siderite is cut by a net
of thin seams containing specularite.

SILVER-LEAD DEPOSITS

Shamrock

The Shamrock property is about a mile above the mouth of the North Fork of
Hayden Creek in Sec. 24, T. 52, N., R. 2 W. It is owned by the Shamrock Silver
Mining Company, incorporated as the Shamrock Mining and Milling Company, February
17, 1932, but changed to the present name July 17, 1935. The property comprises
the Shamrock group of 5 unpatented claims on which the development approximates
1,400 feet of crosscuts and drifts on one level (fig. 7). The property was active
during 1930 and 1931, in 1933, and again in 1936 and 1937. During 1936, 200 feet
of development work was done and all workings were retimbered. In 1937, a station
was cut and work was started on a shaft from a drift on the tunnel level. During
late 1937 and early 1938, work was started on a mill.

The Shamrock is on a zone of intense deformation along which the gray and
black beds of the Wallace formation have been extremely sheared and altered. The
zone of shearing trends N. 15° to 20° E., dips 85° N.W., and crosses the strike
and dip of the Wallace strata at nearly right angles. The zone is not less than
60 feet wide and has been explored for a length of about 150 feet. It has a promi-
inent hanging wall bounded by a conspicuous fracture plane beneath which the rock
is intensely meshed and sheared for a width of 3 to 6 feet. The remainder of the
zone is intricately, though not as intensively, fractured, and shades into an ill-
defined, little-fractured footwall. Some of the fractures of this zone have seams
of gouge an inch or two thick.

The rock throughout the zone has been more or less extensively altered. That
through the intensely meshed zone along the hanging wall has a dark greenish color
and has been extensively chloritized, whereas the remainder has been more or less
completely sericitized and changed in part to a pale greenish sericite with con-
taining a little disseminated pyrite. In places the sericitized rock has associ-
ated greenish blotches of chloritized rock, also partly sericitized.

Through the altered rock are widely scattered small bunches and nests of
pyrite and galena, also thin seams of quartz, some of which contain tetrahedrite
and small masses of ferriferous dolomite or ankerite. In places the altered rock
is heavily impregnated with pyrite for an inch or two and has minor amounts of
galena as bunched rarely more than a few inches thick or a foot long. The quartz is not abundant, but in places has soaked into and has replaced the sericitized country rock. Some of the quartz was deposited before the pyrite, galena, and carbonate; and some was deposited as younger seams containing tetrahedrite. These tetrahedrite seams are mostly less than 1/2 inch thick. Some scattered grains of chalcopyrite were observed with pyrite and quartz in some of the chloritized rock.

The fracture zone appears to be very sporadically mineralized, the sulphides scattered here and there in rather sparse amounts. The shaft is being sunk in the most heavily mineralized part of the fracture zone with the hope that increased depth may disclose oro in commercial amounts. So certain was the management of the outcome that a mill was erected to treat the anticipated ore.

SPECULARITE-ANKERITE DEPOSITS

Burnt Cabin

The Burnt Cabin property is at the head of Burnt Cabin Creek in Sec. 15, T. 51 N., R. 2 W., near the Burnt Creek saddle and fault. It is owned by the Burnt Cabin Mining Company, incorporated April 26, 1928, and consists of 15 patented claims on which are three tunnels (two of them closed) and a shaft. The accessible workings, the No. 2 level and the 100-foot shaft and its crosscuts and drifts, are shown in Figure 6. This company has performed some work annually since its incorporation and the shaft and its lower level have been driven since 1928. The lower drift was being extended during 1937. The logging road of the Ohio Match Company crosses the property just above the camp.

The Burnt Cabin deposit occupies a prominent fissure zone as much as 20 feet wide which cuts obliquely across the upper beds of the St. Regis formation. The strata are somewhat disturbed on either side of the fracture zone, but their general strike is northeast and dip northeast. The fracture zone itself strikes about N. 40° to 50° W. and dips 60° S.W. The mineralized body is from 3 to 6 feet thick, but there are also scattered seams and stringers extending throughout the fracture zone. Post-mineral movement has produced considerable gouge along parts of the deposit, especially along the No. 2 level; but in the drift from the shaft bottom, 100 feet below, the body is frozen to the walls. Other post-mineral faults are also present, some of which parallel the fissure, whereas others strike N. 100 W. and dip steeply east.

The deposit consists mostly of ankerite, quartz, specularite, and pyrite, but contains a little siderite and chalcopyrite. Along the No. 2 tunnel level most of the filling is ankerite, which is cut by coarse plates of specular hematite and contains remnant masses of milky-white quartz. Along the level below the filling is mostly quartz and siderite, cut by only scattered, thin seams of finely crystalline specularite. The mineral relations indicate that quartz was the first mineral deposited, accompanied in the upper level by pyrite and a little chalcopyrite, and then cut by ankerite and small pyrite, and later still by specular hematite. Thin crusts of crystalline pyrite appear in fractures in the filling both near the surface and at depth. The wall rock has been somewhat bleached because of slight sericitization and silicification.

COPPER-QUARTZ VEINS

Hand Spike

The Hand Spike property is along the Little North Fork of the Coeur d'Alene River across from the mouth of LaVernie Creek in Sec. 6, T. 50 N., R. 1 E. The property is owned by the Little North Fork Mining and Milling Company and includes
Figure 9. Geologic sketch map of the Hand Spike vein. Bedrock is Wallace formation. Strike and dip of bedding shown by symbols.
3 patented claims on which are two tunnels, one about 1,700 feet long, the other 600 feet. The company was incorporated September 29, 1903, and much of the development was done at that time or shortly after. At the present time the longer tunnel at river level is still accessible, and a geologic sketch of it is shown in Figure 9.

The development has been on a single vein, the Hand Spike, which cuts beds either of the Burke or Wallace formation. The vein has an average strike of N. 60° W., and has been explored underground for 1,650 feet. It occupies a fault fissure for, as shown in Figure 9, the beds on the northeast side of the vein strike northeast and dip northwest at a low angle, whereas on the opposite side the strike is northwest and the dip southwest at a more moderate angle. The dip of the fault and vein is mostly steeply southwest, but locally is reversed so that the dip is as steeply northeast. The fault is continuously mineralized the full 1,650 feet but not everywhere to the same degree. The vein tonds to swell and pinch and ranges from an inch to 5 feet, its average thickness being about 3 feet. The walls are generally tight, although fairly prominent. The wall alongside is only slightly altered, but in part has a pale greenish color and is distinctly finely micaceous on bedding planes. It has been somewhat sericitized.

The vein is composed mostly of milky-white, rather coarsely crystalline quartz through which are disseminated scattered grains, irregular granules, and small nests of chalcopyrite, partly altered to chalocite and stained by thin crusts of malachite. Pyrite is present but in very small amounts. In one place the filling has been invaded and largely replaced by a pale buff, though otherwise poorly ferriferous carbonate, probably ankerite. Most of the ore removed from the tunnel has been swept away by the river.

**Hamburg American**

The Hamburg American property is on Leiborg Creek about a mile from the Little North Fork in Sec. 31, T. 61, R. 1 E. Its ownership is vested in the Hamburg American Copper Mining and Milling Company, incorporated November 30, 1908; but its charter was forfeited in 1933. The property comprises 3 patented and 4 unpatented claims and the development of two tunnels, the longest about 360 feet (fig. 10). No extensive development has been done for a number of years, and the workings, except in the one tunnel, are inaccessible.

The Hamburg American vein is in the St. Regis formation, which locally trends northwest and dips northeast, a trend which does not conform, however, with the general northwest strike and steep northeast dip of the vein (fig. 10). The vein possesses considerable curvature, but its average strike is N. 45° W. It is exposed for 640 feet underground, ranges from an inch to 3-1/2 feet thick, and occurs in the form of scattered lenses joined by thinner bands and stringers. The vein is cut off on the northwest by a fault (along which the crosstree from the portal was driven).

It is composed largely of milky-white, fairly coarsely crystalline quartz with more or less uniformly scattered grains, granules, and irregular small nests of chalcopyrite, in places accompanied by generally insignificant amounts of sphalerite and galena. In the vein is also considerable poorly but buff-weathering ankerite in the form of rather widely scattered seams, bands, and veinlets penetrating and engulfing the fractured quartz and sulphide. The ferriferous carbonate appears to be more abundant locally than in any other vein in the district. The ore is frozen to the walls and is incased by only slightly altered rock.
Figure 10. Geologic sketch map of the Hamburg-American vein. Bedrock is St. Regis formation. Strike and dip of bedding shown by symbols.

Figure 11. Underground sketch map of the Stroehel workings. Bedrock is Prichard formation. Strike and dip of bedding shown by symbols.
The Varnum property is in Chinese Gulch about 2 miles east of Wolf Lodge Creek in Sec. 34, T. 50 N., R. 1 W., a short distance above the abandoned stretch of U.S. No. 10 highway. It consists of 6 patented claims belonging to the Wolf Lodge Mining Company, incorporated November 7, 1925 (a reorganization of the Home Builder Mining and Development Company, the original incorporation of which dates back to August 13, 1903). This property was active in 1928 and 1929, but the camp has since gone to ruin and all underground workings are inaccessible. The development comprises a shaft 125 feet deep inclined 65° S.W., a drift from the bottom of the shaft, a caved tunnel reported to be about 100 feet long, and a number of surface cuts.

The vein lies in a pre-Cambrian quartz diorite sill about a half mile southwest of the Gemburn fault. The vein was not observed in place, but the alignment of cuts suggests a northwest strike. The inclination of the shaft, which is reported to be on the vein, implies a southwest dip.

Much of the vein-filling exposed on the shaft dump consists of an iron-stained but otherwise milky-white, granular quartz, some of which has scattered granules, small bunches, and irregular seams of partly oxidized chalcopyrite and molybdenite. Some of the quartz has small cavities from which the chalcopyrite has been entirely leached whereas some has remnants of chalcopyrite grains and supergene molybdenite and cuprite. The dimensions of the chalcopyrite body were not learned.

LEAD-ZINC-QUARTZ VEINS

Rainbow No. 2

The Rainbow No. 2, a property of the Rainbow Mining and Milling Company, is on Bootjack Creek about a mile from the Little North Fork, or about 4 miles from the Honeysuckle ranger station in Sec. 24, T. 51 N., R. 1 W. It comprises 3 patented and 1 unpatented claims, and has a tunnel reported to be 1,400 feet long. No work has been done on the property for a number of years and the tunnel is blocked at the portal. According to press reports, the property was leased late in 1937 and work at rehabilitation was to start.

The vein was not seen, but the country rock appears to be the Burke or St. Regis formation, which, in exposures across the creek, strikes about N. 30° W., and dips 28° S.W. A fault several hundred yards to the south brings these beds alongside the Wallace, and another, a short distance to the north, against a lower part of the Burke. The vein is reported to range from a few feet to more than 15 feet wide. Material on the dump indicates that the filling is mostly milky-white, coarsely crystalline quartz, which is accompanied by ankerite and siderite and contains some scattered grains and granules and irregular veinlets of sulphides about equally divided between sphalerite and galena, but including small amounts of chalcopyrite, pyrite, and specular hematite. The filling is more complex than in most veins of the district for both ankerite and siderite were introduced after the quartz and sulphides had been deposited. Specular hematite was introduced after the siderite, the younger of the two carbonates, had been deposited. Some shadow inclinations of the country rock in the vein material indicate that the vein filling has in part been affected by replacement of the somewhat chloritized wall rock.

Silver King

The Silver King property, presumably the old Hidden Treasure, is near the head of Lane Creek about 2 miles from Killarney Lake in Sec. 5 and 8, T. 48 N., R.
The property is an old one but was relocated in 1924. A tunnel driven in the steep gulch some distance below the outcrop is not now accessible and the only vein exposures are in some open cuts spaced about 50 yards apart. A road to the property is no longer usable.

The vein is in the thin-bedded shales and quartzites of the Prichard formation which locally strike about N. 15° W. and dip 40° S.W. The vein has about the same dip as the beds but apparently strikes about W. 35° W. The body is as much as 4 feet thick and consists mostly of milky-white, granular quartz in which are scattered granules and bunches of sphalerite and galena, in places associated with a little pyrite. The sulphides probably comprise less than 5 per cent of the filling.

**Stroebel**

The Stroebel group of claims, which is owned by the Coeur d'Alene-Spokane Mining Company, is near the upper end of Killarney Lake in Sec. 2, T. 48 N., R. 2 W. The company was incorporated September 6, 1918, and its property comprises 3 patented claims on which are a 100-foot vertical shaft (not found) and a tunnel with 600 feet of workings. No work other than annual labor has been done for a number of years.

The essential geologic features of the deposit are indicated on the geologic sketch map (fig. 11). The vein occurs along an intricately fissured and fractured zone in the Prichard formation where the continuity of the beds has been further disturbed by marked drag folding. The vein has a general strike of about N. 50° E. and a dip of 25° to 30° N.E., but it swells and pinches so erratically that its relations are generally obscure. In the southeast drift the vein is 2 feet thick, but in the west end the entire drift and crosscut are in vein quartz, and the body has either expanded locally into a large chimney-like mass or has been joined by veins of nearly flat dip. The expansions appear where the country rock has been most extensively shattered and folded. In addition to the main body, there are numerous accompanying seams and stringers in the fractured rock alongside. The country rock has been extensively altered and has in part been converted to a chlorite schist. The vein has been considerably broken by post-mineral faults.

The filling is composed largely of milky-white, coarsely crystalline quartz accompanied by appreciable amounts of sulphides. It also has a little ankerite and siderite. The sulphides, occurring as grains, coarse granules, irregular seams and veinlets, as well as small irregular masses in previously shattered quartz, consist mostly of galena, lesser sphalerite, together with some chalcopyrite, arsenopyrite, and pyrite. In some places, the vein has a well-defined ribbon structure.

**Radio**

The property of the Radio Mining Company is near the head of the South Fork of Varnum Creek in Sec. 20, T. 48 N., R. 2 W. The company was incorporated December 13, 1928, and the property consists of 5 unpatented claims on which are three tunnels with more than 2,600 feet of workings. This property was active in 1929, in 1932, in 1934, and each year since. Its camp buildings were destroyed by fire in August, 1932, and have not been rebuilt. One of the tunnels, apparently the one in which the more recent work has been done, was examined; the other two were not found. This tunnel had about 1,375 feet of accessible workings (fig. 12).

The outcrop of the vein was not seen nor was the vein disclosed underground, except possibly at the cave in the south branch of the tunnel (fig. 12). At this point the Prichard is somewhat hydrothermally altered and is cut by a fissure zone.
Figure 12. Sketch map of the Radio tunnel. Bedrock is Prichard formation. Strike and dip of bedding shown by symbols.

Figure 13. Sketch map of the accessible workings on the Gray Eagle property.
several feet wide in which is much gouge and a little vein quartz. The strike of the fissure appears to be N. 100° E. and the dip 45° S.E.

There is considerable float in the gulch above the portal of the tunnel. This float consists of milky-white granular quartz in which are some widely scattered cubes and grains of galena.

Gray Eagle

The Gray Eagle property is north of Lake on the opposite side of the Coeur d'Alene River in Sec. 1, T. 50 N., R. 2 W. Work on the property started about 1907 and continued for 6 years during which time several tunnels were driven into the slope and a 75-foot shaft was sunk in the gulch below. At present one tunnel is accessible. It has 322 feet of crosscuts and drifts and a 70-foot inclined shaft at the point where the crosscut intersects the vein (fig. 13).

The vein is along a prominent fault fissure of about N. 45° E. strike and 60° to 60° S.E. dip, which is transverse to the general northwest strike and northeast dip of the Frichard formation. At the point where the crosscut intersects the fissure, the vein is about 16 feet wide; but in less than 80 feet to the northeast it is 2 feet wide and less than 25 feet to the southwest it is about 3 feet wide. The 52° dip of the footwall and the 64° dip of the hanging wall also indicate that the body pinches with depth (fig. 13). The vein has a well-defined footwall of crushed rock produced by post-mineral movement, but the hanging wall is tight. The vein is composed almost wholly of coarse, granular, milky-white quartz, which in places has scattered granules of galena and sphalerite, lesser amounts of chalcopyrite, and scant pyrite and arsenopyrite.

Open cuts on nearby ridges and slopes indicate the presence of other quartz veins, none of which has been adequately prospected to determine size and continuity.

King Solomon

The King Solomon property is in the Fourth of July Canyon several hundred yards above the mouth of Caran Creek and covers a vein which crops out along the crest of the ridge less than a quarter of a mile north of the canyon bottom. The vein has been exposed in a series of cuts along the ridge and has been prospected at depth by diamond drills. Encouragement afforded by two of the diamond drill cores prompted the owners of the property, the King Solomon Mining and Milling Company, to erect a compressor building and construct camp in the Fourth of July Canyon during the summer of 1937 and to begin a long crosscut about 50 feet above the canyon floor. An older 600-foot adit on the opposite side of the ridge was abandoned. The company was incorporated September 6, 1935, and controls two claims.

The average strike of this vein is about N. 35° W. and its dip is 30° N.E. It is about parallel to the Osburn fault which lies a half mile to the northeast. The vein may be traced for several hundred yards by the alignment of surface cuts along its outcrop. In some of the cuts it is about 4 feet thick, but is reported to be 16 feet where cut by two of the diamond drill holes.

Most of the vein consists of massive, white, coarsely granular quartz. In some of the surface cuts the quartz shows leached veins, but just beneath the surface it contains scattered crystals and grains of coarse arsenopyrite and smaller amounts of irregular grains and granules of pyrite, galena, and sphalerite. These sulphides appear to be grouped in very irregular bunches and to be distributed very sporadically. Nowhere did these sulphides make up as much as 5 per cent of the filling. The thinly bedded Frichard "slate" which forms the wall rock has been
partly changed to a chloritic ashist.

**King Tut**

The King Tut is in the Fourth of July Canyon about 1-1/4 miles above the King Solomon at the mouth of Mill Creek. The vein is exposed at the portal of a caved tunnel and shows 4 feet of white massive quartz, in part coarse and drusy. The vein, striking about N. 80° W. and dipping about 25° S.E., is bounded by prominent walls. The quartz at the portal is somewhat iron-stained but is without leached vugs. Elsewhere the quartz is reported to contain galena.

Some other cuts and caved tunnels occur a short distance to the south along Mill Creek, but whether these are on the King Tut vein or on others was not determined. Like the King Tut, these are in the thinly laminated shales of the Pichard formation which locally strikes N. 46° W. and dips 30° N.E.

**SILVAN-QUARTZ VEINS**

**Commonwealth**

The Commonwealth mine is on Hayden Creek just below the mouth of the North Fork in Sec. 26, T. 52 N., R. 3 W. It is owned by the Commonwealth Metals Company, incorporated March 19, 1924, and comprises the Commonwealth group of 7 unpatented claims on which are a vertical shaft 326 feet deep, two inclined shafts 180 and 226 feet deep, and two tunnels, No. 1, 470 feet long, and No. 2, 80 feet long. No work other than annual labor has been done for many years and none of the workings could be entered in 1937. Some ore was shipped prior to 1916, but the amount shipped and its value was not learned. The entire surface plant has been dismantled. An old map of the underground workings is reproduced in Figure 14.

The Commonwealth is on one of the largest and most conspicuous quartz veins in the district. This vein strikes about N. 25° E., dips 75° S.E., and may be traced on both sides of Hayden Creek for at least 2,000 feet by its reddish and brownish iron-stained cropping, which in places projects as much as 50 feet above the surface. A short distance north of the shaft it forms a bold bluff 100 feet high. At the surface the vein appears to be mostly 10 to 20 feet thick, but the underground map indicates that it may be considerably thicker.

This vein is composed largely of white granular quartz, heavily iron-stained on the surface, but showing some thin patches of malachite and azurite. It also contains variable but scant amounts of barite. The unoxidized vein matter has more or less widely disseminated minute grains and granules of sulphides, few of which are individually recognizable to the unaided eye. In the few pieces of ore remaining on the dump are small quantities of pale brownish grains of sphalerite, some tetrahedrite, and a little pyrite, galena, and chalcopyrite. Much of the vein appears as a cemented quartz breccia. A milky-white, fairly coarse-grained quartz was deposited first. It was later extensively broccolized and then cemented by a much more finely crystalline quartz with associated barite and scant amounts of sulphides. After another period of fracturing and brecciation, a third generation of quartz was added to widely spaced fractures in the form of seams of fairly coarse crystalline combs. As the vein was not uniformly reopened during these different stages of structural adjustments, the sulphides are not uniformly distributed but are confined to more or less well-defined shoots within the quartz vein. According to mine records, several ore shoots were exposed in the underground workings which varied in the quantity of different metals present. Assay records show that much of the ore carried from 0.02% to 0.04% ounces of gold per ton and from 4 to 50 ounces of silver. The amount of copper rarely exceeded 1% and the lead...
Figure 14. Map of the underground workings of the Commonwealth mine. (From plans and section by E. C. Wood, M.E.)
4 per cent. Sphalerite is apparently the most abundant mineral for some of the assays reveal as much as 32 per cent zinc, although generally the percentage is less than 5 per cent. It appears that the ore is more or less bunched and confined to individually small shoots.

UNDIFFERENTIATED DEPOSITS

Crystal Spring

The property of the Crystal Spring Mining Company, which comprises 8 unpatented claims, lies along the canyon south of Wall Peak about a mile north of U. S. Highway No. 10, mostly in Sec. 15, T. 2, G. N., R. 1, W. The company was incorporated July 12, 1936. In 1937, work had begun on construction of a compressor building and on a long adit drift from creek level to undercut some old workings about 1,000 feet above and half a mile to the north. These older workings comprise a 60-foot inclined shaft, connected by a 30-foot crosscut, and several open cuts.

The property lies from 1 to 2 miles north of the Cabinburn fault in the thin-beded shales of the Prichard formation. The adit drift at the canyon bottom, which was in 100 feet when the property was visited, showed a broad zone of intensely sheared and altered country rock and locally a chloritic schist, in which were some narrow, irregular quartz seams and stringers, some of which had a strike of N. 35° W. and a vertical dip. The strike of the loss disturbed Prichard nearby is N. 26° W. and the dip 36° N.E. The alignment of the cuts and shaft high on the ridge suggests that locally the shearing trends N. 30° E. and dips 45° N.E. These cuts also reveal a broad zone of intensely meshed and chloritized country rock, containing stringers and small bunches of quartz.

Some of the quartz bunches are as much as 4 feet thick but most are much smaller. In places the quartz contains considerable pyrite, either as massive granular nests or as more widely scattered grains, granules, and crystals. The quartz is the coarse, milky-white variety and, in part, shows an ill defined ribbon structure. Some specimens at the portal of the adit contained a few small scattered grains of chalcopyrite and a little pyrrhotite. Thin seams of ankerite were also visible.

Connie

The Connie, formerly known as the Dundie, is on the upper south slope of South Chilco Mountain in Sec. 14, T. 62 N., R. 2 W., at an altitude of about 4,800 feet. It is owned by the Connie Mining and Milling Company, incorporated July 11, 1927, a reorganization of the Chilco Mining and Milling Company, the incorporation of which is dated September 14, 1925. The property comprises the Chilco group of 11 unpatented claims and includes a tunnel about 1,300 feet long (fig. 15). The most recent development work was done between 1931 and 1933, inclusive, when the length of the tunnel was increased 600 feet.

The vein strikes about N. 45° E. and dips 70° to 90° N.W. It cuts transversely across the Burke formation, the beds of which strike about N. 30° W. and dip 20° S.W. The vein has been exposed underground for about 900 feet. Its average thickness is 18 inches, but locally the vein swells to 4 feet. In three places it has been offset by faults of N. 20° W. strike and 60° to 70° S.W. dip. The offset by the first two faults has been negligible (fig. 15), but the continuation beyond the third fault was not found. On intersecting the third fault, the tunnel was directed northward for nearly 500 feet, but exposed only slightly micaceous quartzite, metamorphosed by emulsions from the granodiorite body which outcrops less than a mile to the north.

The vein is composed of white, fairly coarse crystalline quartz, which in 63.
Figure 15. Geologic sketch map of the underground workings at the Connie property. Bedrock is Burke formation. Strike and dip of bedding shown by symbols.
places is somewhat fractured and impregnated with scant amounts of sulphides, mostly arsenopyrite but including a little pyrite, sphalerite, and galena.

Bradbury

The Bradbury group of claims is at the head of the North Fork of Hayden Creek in Sec. 9, T. 52 N., R. 2 W. The property is owned by the Hayden Lake Mining and Milling Company, incorporated May 8, 1917, and consists of 12 unpatented claims on which are two tunnels, one with about 1,600 feet of workings, the other with about 800 feet. Little active work has been carried on since 1923, and in 1937 only the lower No. 1 tunnel was open (fig. 16).

The geologic relations as observed on the No. 1 tunnel level (fig. 16) are not wholly clear, and whether there are three separate overlapping quartz veins or but one broken into three segments by faulting, was not definitely determined. The country rock consists of somewhat disturbed but not much altered quartzite beds of the Wallace formation which locally strike northeast and dip northwest at a moderate angle. The vein, or veins, appears in general to conform rather closely with the strike of the strata; but the angle of dip is much greater than the dip of the strata and in places is in the opposite direction. The veins are extremely irregular as to thickness and pinch and swell abruptly (fig. 16). In places they are about a foot thick; in other places, 30 feet. They are also bordered by a fringe of quartz seams and stringers which extend outward at diverse angles, but for no great distance. The bodies have been cut by some faults of N. 10° W. strike, but displacement along them does not appear to exceed a few feet.

The veins are composed mostly of medium to fairly coarse-grained white quartz, in places somewhat shattered and containing scattered small crystals and granular pods of pyrite and lesser amounts of arsenopyrite and chalcopyrite. Galena is reported. Some scattered thin seams of carbonite and siderite cut and replace the quartz and its sulphides. The quartz is partly a filling but mostly a replacement of the country rock, and commonly contains chloritized fragments and shadow-like inclusions of the wall. Some of the chalcopyrite granules have thin crusts of greenish malachite.

R. M.

The R. M. property is 1-1/2 miles up the North Fork of Hayden Creek in Sec. 18, T. 52 N., R. 3 W. It is an old property but has had some recent work. The development comprises a tunnel 50 feet long on the east side of the creek and another less than 10 feet long on the west side. That on the east side has been driven beneath a bold quartz outcrop as much as 40 feet high and 40 feet wide. The vein cuts the Wallace formation and appears to strike about N. 35° W. and dip 70° N.E. That across the creek has a similar strike and dip, but its thickness ranges from 12 to 15 feet. Another vein is known to occur nearby. The veins are composed of milky-white, coarsely granular quartz, in part massive, in part with included broclic fragments of little altered country rock. Some of the quartz is slightly iron-stained, but no sulphides were observed.

Two Brothers

The Two Brothers claim is about half a mile northeast of the R. M., on a tributary of the North Fork of Hayden Creek, along the forest trail to Bucklas Mountain. It covers a prominent quartz vein which may be traced a long distance on the surface because of its superior resistance to erosion. The vein strikes N. 40° E. and apparently dips steeply southeast. The only development has been a small open out at a point along the bottom of the gulch where the vein is at least 40 feet.
Figure 16. Geologic sketch map of the lower tunnel of the Bradbury property. Bedrock is Wallace formation. Strike and dip of bedding shown by symbols.

Figure 18. Geologic sketch map of the main tunnel on the Royal property. Bedrock is Prichard formation. Strike and dip of bedding is shown by symbols.
thick. The vein is composed of white quartz in which are inclusions of little al-
tered country rock.

Buckles

The Buckles property is about 1/2 mile west of Buckles Mountain in the same
gulch as the Two Brothers but in Sec. 17, T. 55 N.; R. 2 W. It has a tunnel with
about 165 feet of workings in and along a prominent vein of N. 40° E.; strike and
steep northeast dip. This vein is from 10 to 15 feet thick, cuts quartzitic beds of
the Wallace formation, and projects as much as 10 feet above the surface. It
is composed mostly of white barren quartz, in places cut by thin seams of ankerite
in which are widely scattered small grains and crystals of pyrite.

Jennings

The Jennings group of claims, including the Spade, Kootenai, Shoshone, and
others, are on Mekins Creek about 2 miles west of Spades Mountain in sections 5 and
8, T. 51, N.; R. 2 W. These claims are crossed by the Ohio Match Company railroad
and there are tunnels both above and below the track. The portal of the tunnel on the
Shoshone claim is at track-level and the tunnel extends 190 feet along a frac-
ture zone of about N. 50° E.; strike. This fracture zone cuts the Wallace formation,
which locally trends N. 420° W. and dips 15° N.E. The fracture zone is from 5 to
10 feet wide and is bounded by firm walls which dip 70° N.W. At the face of the
tunnel this zone is cut off by a fault of N. 40° W. strike and 60° S.W. dip. The
fracture zone has up to 10 inches of vein carbonate but apparently is without sul-
phides.

The workings on the Kootenai claim are near creek level and comprise a cross-
cut and drift nearly 600 feet long. These workings are also in the Wallace form-
ation. Ninety-five feet from the portal the tunnel encounters and is directed
along a vein 3 to 4 feet thick which strikes about N. 105° W. and dips 40° S.W.
This vein comprises crushed and fractured rock with a band of calcite 1 to 2 feet
thick. At 225 feet the drift encounters an intersecting vein, which strikes N.
55° E. and dips 85° N.W. The intersecting vein is followed to the northeast for
155 feet. This second vein is from 1 to 2 feet thick and is composed largely of
quartz, in thin seams and stringers and/or as small lenses not more than 6 inches
thick. With the quartz are also a little pyrite and dolomitic carbonate.

Great Western Copper

The Great Western Copper Company has two properties, one about a mile south of
Lane near the Coeur d'Alene River, the other near Hayden Lake. This company was
incorporated November 20, 1931, and acquired the mineral rights to 160 acres of
land near Lane and to 4 unpatented claims near Hayden Lake.

At Lane the company drove a tunnel about 720 feet long to undercut some shal-
low workings in the gulch on the opposite side of the low ridge. This work was
apparently abandoned in 1934 and the tunnel is now caved at the portal. The tunnel
is driven through black slate in the Prichard formation which locally is somewhat
micaceous and shows minute grains of biotite. No ore, or hydrothermally altered
rock, was observed on the dump but brecciated and somewhat altered Prichard, ce-
mented by a little quartz, remains on the dumps of short, caved tunnels in the
gulch to the east.

The property near Hayden Lake is on the lower South Fork of Mekins Creek a
mile from its mouth. The development consists of a 350-foot tunnel and a 60-foot
shaft at the bottom of which is a 70-foot drift. The tunnel is caved at the portal.
The vein was not seen in place, but some vein matter on the dump is composed of

65.
iron-stained, white quartz. The vein is reported to have been prospected for copper, gold, silver, and lead.

**Homebuilder**

The Homebuilder is on upper Wolf Lodge Creek, a short distance below the mouth of Phantom Creek, in sections 11 and 12, T, 50 N., R. 2 W. The property belonged to the Homebuilder Mining and Development Company from the time of its incorporation in August 15, 1908, until its reorganization as the Wolf Lodge Mining Company, November 7, 1925. At one time the property comprised as many as 46 unpatented claims and had a fully equipped mine plant and camp. The company remained active for many years and drove approximately 5,000 feet of tunnels. The work terminated in 1923 after a large amount of diamond drilling had been done. Since then the property appears to have been abandoned, for the camp is in ruins and the underground workings are entirely inaccessible.

The vein was not seen and nothing was learned of its size and structural relations. It is enclosed either in the upper Pritchard or lower Burke formation. The beds at the portals of the main tunnel strike N 20° W. and dip 35° N.E. No quartz or other minerals were on the dump and the character of the mineralization was not revealed. Annual reports of the State Mine Inspector indicate that the ore sought was silver and gold.

**Idaho Chain Link**

The Idaho Chain Link property is on Wolf Lodge Creek about 1/2 mile above the Homebuilder. It has no less than 4 short tunnels, one of them along a grayish, biotite-monzonite dike. This dike has rather conspicuous biotite crystals and resembles a micro lamprophyre, except for its lighter color. No ore was seen at the portals of any of the tunnels nor in the workings within.

**Brower**

The Brower property is on a branch of Wolf Lodge Creek, a mile or more above the Idaho Chain Link, apparently in Sec. 1, 2, 50 N., R. 2 W. It has a tunnel more than 100 feet long started in deeply weathered Rovett quartzite. A few fragments of white quartz were found on the premises, but no ore was observed underground.

**Idaho Diamond Sulphide**

The property of the Idaho Diamond Sulphide Mining Company is on the east slope of Mica Peak in the drainage of the North Fork of Mica Creek, probably near or in Sec. 1, 2, 49 N., R. 5 W. It is reached by road from Cougar Creek. The company was incorporated July 10, 1936, and its property consists of 2 unpatented claims on which is an old tunnel carved at the portal, reported to be several hundred feet long, and an 80-foot shaft on the slope below, from which a crosscut was being driven in 1937 to cut a copper-bearing vein reported to be exposed in the tunnel above.

The property is in an area of mica, hornblende, and foldeopathic gneisses and schists within the main mass of the gneissic complex of the Selkirks. In and adjacent to the property the biotite of the schists and gneisses has been altered to a golden-brown vermiculite, which, when heated, expands and increases its volume several times. Beds of sufficient purity to warrant commercial exploitation have not yet been found. In some beds, the vermiculite occurs as scattered grains, in a few it probably forms nearly half of the rock, but it is everywhere admixed with more or less hornblende, quartz, and feldspar. The present shaft is reported...
Figure 17. Underground workings at the Red Horse property. Bedrock is Prichard formation. Strike and dip of bedding shown by symbols.
to have passed through a 4-foot bed in which the vermiculite was especially abundant, but the altered biotite schist was not seen in place. The vermiculite also appears at the portal of the tunnel and in open cuts, and is apparently widely spread locally.

Red Horse

The Red Horse property is in the deep canyon below Red Horse Mountain in sections 5 and 7, T. 46 N., R. 2 W. Access to it is by way of Blue Lake and Blue Creek from the Coeur d'Alene River. The property was operated by the Red Horse Mining Company, the incorporation of which dates back to July 14, 1904. This company had a completely equipped mine plant and camp, and continued operations as late as 1929. The ore is reported to be copper, but during 1925 a 5-ton mill was constructed to recover platinum which had been reported by "platinum assayers." The development was confined to a single tunnel which is still open and which has about 2,700 feet of workings (fig. 17).

The tunnel is entirely in the dark-colored, for the most part quartzitic and somewhat micaceous, beds of the Přichard formation, which show local changes in strike and dip (fig. 17). Nothing of consequence was exposed underground except a fault and an early Tertiary diabase dike (shown as pre-Cambrian diorite in Figure 17). The fault is exposed in two places and is outlined by about 2 feet of crushed and pulverized rock. The diabase dike appears in the face of two short cross-cuts near the far end of the tunnel. A copper-bearing quartz vein is reported to occur somewhere above on the mountain slope.

Royal

The Royal property owned by the Royal Basin Mining Company, which was incorporated December 24, 1910, as the Royal Mining Company but changed to its present name June 8, 1924, is in the Beauty Bay district about 2 miles above the mouth of Beauty Creek in Sec. 16, T. 49 N., R. 2 W. The property consists of 3 unpatented claims, the principal one (fig. 18) being about 500 feet long. This property was active from 1928 to 1932 and again in 1934, but work since then has been negligible.

The geologic features of the property are shown in Figure 18. The tunnel reveals no well-defined zone of mineralization but exposes two bodies of granite porphyry and one of hornblende-biotite diorite. These invade Přichard strata which locally have been metamorphosed to dark gray, micaceous quartzites by emanations from the stock of porphyritic quartz monzonite exposed half a mile away. In places the rock has small, widely scattered grains of pyrrhotite and pyrite.

Lost Man

The Lost Man is in the Beauty Bay mining district on a tributary of Vermilion Creek about half a mile above the Silver Tip, apparently in Sec. 16, T. 49 N., R. 2 W. The work comprises several cuts along the creek in which are exposed breccias of talus fragments and slope-wash with admixed stream gravels cemented by iron oxide. The cemented breccia is as much as 12 feet wide and may be traced along the valley bottom in a northerly direction for several hundred feet. The breccia has apparently been cemented by iron oxide deposited from surface waters.