STATE OF IDAHO
C. Ben Ross, Governor

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IDAHO BUREAU OF MINES AND GEOLOGY
A. W. Fahrenwald, Director

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GEOLOGY AND ORE DEPOSITS
NEAR EDWARDSBURG AND THUNDER MOUNTAIN, IDAHO

By
P. J. Shenon and C. P. Ross

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Prepared in cooperation with
the United States Geological Survey

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University of Idaho
Moscow, Idaho
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This report presents the salient results of P. J. Shenon's studies of the geology and ore deposits of the Thunder Mountain district and of the area near Edwardsburg, together with a summary of the results of a geologic reconnaissance, by C. P. Ross, of the eastern division of the Idaho National Forest, which includes both of the areas studied in detail.

The Idaho batholith, composed of quartz monzonite and related rocks, underlies most of the region. It is in part bordered by more dioritic rocks that belong, on the whole, to an early stage in the emplacement of the Batholith. Parts of this border zone include gneissic material formed in rocks of the Belt series by a complex process of replacement and injection by magma related to the Batholith. More or less extensive remnants of the Belt rocks, Paleozoic sedimentary beds, and Permian volcanic strata into which the Idaho batholith was intruded remain in different parts of the region. These old rocks are locally overlain by the Challis volcanics (Eocene or early Miocene), which formerly covered much of the region but have been extensively dissected. Several masses of Tertiary granitic rocks and numerous related dikes are present. The most conspicuous dike zone, that near Edwardsburg, is discussed in detail.

Both lode and placer deposits are present. The placers have not yet been extensively developed, and their production to date is small, in part because of the abundance of large boulders in the more accessible deposits. Some gravel-floored meadows have received little or no testing because of their remote locations.

Most of the lode deposits are regarded as genetically related to the Tertiary intrusive rocks. Those within the Challis volcanics have so far been worked only in the Thunder Mountain district, where the total production to date is about $335,000. They are irregular replacement deposits, mostly of broad lateral but apparently small vertical extent.

Most of the lodes in pre-Tertiary rocks are mineralized shear zones or quartz veins, although there are also a few deposits of contact-metamorphic type. The deposits in shear zones are very large, and more can be traced long distances, but the average tonor of the ore is low. Quartz veins are numerous, and some contain ore shoots of comparatively high tonor. So far, the recovery from the lodes in pre-Tertiary rocks described in this report has been small, with the single exception of the Golden Hound which has recently become productive. The scanty development to date has resulted in part from the handicap of a severe winter climate and scarcity of roads. In the last few years new roads and airplane landing fields have been built, and others are projected, so that the difficulties of transportation are rapidly being overcome.
INTRODUCTION

Scope of report

This report embodies preliminary results of detailed studies carried on in the Thunder Mountain district and in the general vicinity of Edwardsburg in 1933 and 1934 by E. J. Shanon, assisted by O. P. Enigh, together with data obtained by C. P. Ross in a brief visit to the Thunder Mountain district in 1928 and a month's reconnaissance in the eastern division of the Idaho National Forest in 1929. (See fig. 1.) The principal results of Ross's work in the Thunder Mountain district have already been published.

The reconnaissance geologic map (fig. 2) and the discussion of the broader features of the general geology are mainly by Ross. Certain of the prospects in Chamberlain Basin and along lower Big Creek were visited only by Ross. Except for figure 2, which is by Ross, the maps in the present paper and the descriptions of most of the mines and of the diggs near Edwardsburg are by Shanon.

Acknowledgments

All of the mining people who were met in the course of the field work gave information and assistance freely. Messrs. W. A. Edwards, Henry Abstein, F. C. Innes, A. P. Richards, James Hornberger, Walter Estep, A. C. Behne, Sam Wilson, Tony Ludwig, and N. C. Bush, of the Edwardsburg district, and L. C. McCrane, Robert McRae, C. W. Neff, William Timm, Samuel Hancock, and J. J. Oberbillig, of the Thunder Mountain district, spent considerable time and energy in assisting the writers.

Accessibility

Much of the area described in this report is relatively inaccessible, largely because of its ruggedness and severe winter climate. However, in recent years new roads have improved transportation facilities greatly.

A serviceable road now connects a branch of the Oregon Short Line Railroad at Cascade with Yellow Pine and Stibnite, respectively 70 and 84 miles distant. Until 1933 the only road into the Edwardsburg district was that from McCall by way of Warren. This road, which crosses several very high summits and deep canyons, is 84 miles long and is usually closed by snow from some time in October to about the middle of July. In 1933 a road was completed from Yellow Pine to Edwardsburg, which much facilitated access and lowered the freight costs considerably. In 1934 the Forest Service began building a road down Big Creek. This is to connect with another road started from Stibnite, which was completed as far as the head of Monumental Creek in 1934 and presumably will be continued down Monumental Creek through the Thunder Mountain district in the near future. A road down the Salmon River is also under construction and appears to promise the best all-year outlet for several of the mining districts when branch roads are built up the larger tributaries.

In recent years airplages have been used to a considerable extent for winter travel and for carrying mail. There are now landing fields at Yellow Pine, Stibnite, Edwardsburg, Chamberlain Basin, and Soldier Bar. The last-named is on Big Creek just east of the area mapped in figure 2.

Figure 1. Index map of Idaho showing area covered in Figure 2.

- A -
Production of the Wilbert mine
from the time of its discovery to January 1, 1930

By H. S. Knight

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<tr>
<th>Period</th>
<th>Crude ore (tons)</th>
<th>Concentrates shipped (tons)</th>
<th>Silver content (ounces)</th>
<th>Lead content (pounds)</th>
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<td>10,000</td>
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<td>1912-18</td>
<td>59,000</td>
<td>19,295</td>
<td>173,655</td>
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<td>1924 ²/</td>
<td>1,417</td>
<td>564</td>
<td>14,530</td>
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<td>1925</td>
<td>3,882</td>
<td>1,014</td>
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<td>1926</td>
<td>1,678</td>
<td>515</td>
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<td>1927</td>
<td>7,901</td>
<td>2,175</td>
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<td>1928</td>
<td>11,280</td>
<td>1,838</td>
<td>30,373</td>
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<td>1929</td>
<td>14,355</td>
<td>3,152</td>
<td>55,530</td>
<td>3,342,836</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100,993</strong></td>
<td><strong>29,753</strong></td>
<td><strong>341,703</strong></td>
<td><strong>31,249,637</strong></td>
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²/ No production in 1918-24.
Bibliography

The following list includes the principal published papers dealing with the region. In addition to the papers listed separately, the reader interested in details of the history and production should consult the chapters on Idaho in the annual volumes of Mineral Resources, written by V. C. Heikes for the years 1905 to 1907, and by C. N. Gerry from 1908 to the present time. These volumes were published for the years up to and including 1923 by the United States Geological Survey and since then by the United States Bureau of Mines. The annual reports of the Idaho inspectors of mines also contain much valuable information pertaining to the region.


**TOPOGRAPHY**

The region is in the northern part of the Salmon River Mountains and comprises most of the eastern division of the Idaho National Forest. It comprises most of the region bounded on the north by the Salmon River, on the east by the Middle Fork, and on the west by the South Fork or that river. The East Fork of the South Fork of the Salmon River is near the southern boundary. All these streams flow in steep, narrow canyons with rugged, in part precipitous, walls. The region enclosed by them is a block of relatively high country, sharply delineated by these canyons and bisected by Big Creek.

The Middle Fork cuts directly through the highest country in this part of Idaho. On the east are the Big Horn Crags, with numerous summits over 9,500 feet above sea level and culminating in McGuire Peak at 10,070 feet. On the west is an unnamed range marked by Black Butte (8,794 feet), Papoose Peak (8,996 feet), Cottonwood Peak (9,351 feet), and others. This range has a fairly even crest rising northward. The descent to the Middle Fork, with an altitude of 3,000 feet at its mouth, is almost precipitous. North of the valley of Big Creek, in the central part of the region, there is a relatively low area with rolling ridges, intervening valleys, and flat meadows (fig. 2). In this low area few summits rise much higher than 7,500 feet above sea level and there are many long, relatively flat-topped ridges with altitudes between 6,500 and 7,000 feet. The narrow ridge that trends about N. 15° E. from the vicinity of Cold Mountain has summits over 6,600 feet, and is a conspicuous exception. The major valleys in this area trend northeast in conformity with the lower course of Middle Fork and the trend of its flanking ranges. These valleys are characterized by broad, somewhat marshy flats or meadows, most of which are a little over 5,000 feet above sea level, although the largest one, Chamberlain Basin, is for the most part somewhat lower. Below these meadows the streams flow in gradually deepening gorges to the Salmon River, which in this vicinity flows at altitudes of 2,600 to 2,800 feet. Near the river the steep-walled, narrow canyons are quite impassable.

The area of rolling topography is bounded on the west by the higher and more rugged mountains east of the South Fork of the Salmon River, including Mount Eldridge and Wolf Range, Chinese, and Sheepster Peaks. These range in altitude from about 8,600 to nearly 9,000 feet, but do not form as distinct a range as those close to the Middle Fork.

On the north the rolling country is also partly bounded by a relatively sharp ridge of higher ground. This ridge extends from the head of the Witch
Figure 2. Reconnaissance geologic map of part of the eastern division of the Idaho National Forest.
Pork of Chamberlain Creek nearly to the mouth of Chamberlain Creek at an altitude close to 7,000 feet; its remarkably flat crest forms the southern edge of this portion of the canyon of the Salmon River and is about 5 miles distant from the river.

Big Creek is incised in mountains that rise on each side to altitudes of over 8,000 feet. South of it there is a rugged country with little system in the arrangement of the topographic units except for the tendency of the streams and ridges to conform approximately to the northeasterly trend so prominent farther north. Cliffs and pinnacles are more abundant and slopes steeper and more irregular than in much of the country north of Big Creek. Near Edwardsburg there is less accordance of level than in many other parts of Idaho. Here some peaks are as much as 9,300 feet high. The gravel-floored flats along Big Creek just south of Edwardsburg are in sharp contrast to the neighboring mountains. Along the southern border of the region some summits are fully as high as any farther north, but more or less gently rolling uplands are more conspicuous. In most localities in this part of the region the topography is that of an old plateau so intricately and deeply dissected by streams that the original character can be readily perceived only from high vantage points.

GENERAL GEOLOGY

Foreword

About one-half of the region covered by the accompanying geologic map (fig. 2) is underlain by components of the Idaho batholith, but considerable remnants of the Belt series and of Paleozoic strata, both sedimentary and volcanic, have survived erosion. Miocene granite is present in the southeastern part, and Tertiary dikes, which are not shown on figure 2, are present in many localities. Much of the southern part of the area is covered by Challis volcanic of upper Oligocene or lower Miocene age. With the possible exception of the Paleozoic sedimentary rocks and some of the components of the Idaho batholith, the formations of this region are the same as those of the Casto quadrangle 1/2, to the southeast.

The geologic boundaries in figure 2 were sketched in the field on a Forest Service map. Dashed lines indicate the probable position of boundaries in areas observed only from considerable distances or hidden by intervening elevations from occupied points. Time was insufficient to permit mapping of the Tertiary dikes over the large area, but these rocks were mapped in detail near Profile Gap, as shown in figures 3 and 4.

Belt series (pro-Cambrian)

The rocks of the Belt series exposed in the northeast corner of the Casto quadrangle were subdivided into the Hoodoo quartzite and the underlying Yellowjacket formation. 2/ Those rocks have been invaded by the Idaho batholith and by granitic rocks of Tertiary age. As a result of deep erosion, only remnants of the Belt rocks remain over a very large area to the northwest of the Casto quadrangle, and these are in part concealed by later formations. However, it has been possible to correlate the many scattered areas of these rocks because of lithologic and stratigraphic similarities. The largest areas in which these rocks are exposed lie between Monumental Creek and the headwaters of Big Creek. Their

stratigraphic relations are like those in the Casto quadrangle, but the base of the Yellowjacket formation is concealed as effectively here by the Idaho batholith as it is in the Casto quadrangle by the Tertiary intrusive rocks. In the vicinity of Big Creek the massive, nearly white Hoodoo quartzite, so thoroughly recrystallized that in many outcrops bedding cannot be discerned, rests on the more argillaceous and consequently more crumpled Yellowjacket formation. The Casto volcanics (Permian (?)) rest unconformably on both of these Belt formations, just as they do in the Casto quadrangle.

Yellowjacket formation

Most of the Yellowjacket formation is a dark-gray, in part creamish argillaceous quartzite, generally with small-scale cross-bedding. In some places, notably on Monumental Creek, the rock has been so bleached by igneous metamorphism that it locally resembles the more micaceous varieties of the Hoodoo quartzite. On upper Smith Creek, and less abundantly elsewhere, there are originally calcareous beds that now contain such contact-metamorphic minerals as scapolite, amphibole, and garnet. In that locality, and farther down Smith Creek, near the Route 14 mine and among the inclusions in the gneissic quartz diorite on the west side of Crooked Creek, relatively pure light-gray crystalline limestone occurs. Some of the smaller masses of the Yellowjacket formation that were mapped, especially in the northern part of the region, contain so much infiltrated granitic material that they are decidedly gneissic.

Nearly everywhere the Yellowjacket formation is crumpled and contorted, and measurements of its thickness were not obtained during the present study. The base of the formation is nowhere exposed. In the Casto quadrangle there are nearly 2,000 feet of Yellowjacket beds, and near Big Creek the formation appears to be fully as thick.

Hoodoo quartzite

The Hoodoo quartzite is a white, comparatively uniform, massive, hard, brittle rocks. It is composed almost entirely of quartz and is thoroughly recrystallized, so that in many places bedding cannot be distinguished. In the vicinity of Big Creek, Hoodoo quartzite rests upon crumpled members of the Yellowjacket formation. From 2,000 to 4,000 feet of the quartzite is exposed near Ramsey Creek.

Paleozoic rocks

Quartzite and limestone

East of Profile Creek, in the southwestern part of the region, there are beds of quartzite and limestone distinctly different from the Belt rocks described above. They are evidently the northwestward continuation of the Paleozoic strata that contain the cinabar lodes of the Yellow Pine district. As mapped on figure 2, they include the quartzite on the East Fork of the South Fork of the Salmon River, which was tentatively regarded as of pre-Cambrian age in the study of the Yellow Pine district, but was not mapped separately in that report. Exposure near Pinnacle Peak and along Missouri Creek indicates that in general the limestone overlies the quartzite, but in places there is some interbedding. This

accords with Livingston’s tentative conclusion 1 as to the stratigraphic relations in the vicinity of the cinnaabar lodes farther south. Those who have studied the beds in the Yellow Pine district 2 agree that they are probably lower Paleozoic, although no diagnostic fossils have been found in them.

The quartzite is a nearly white rock, generally with little or no mica and other impurities. It is coarser-grained than the Hoodoo quartzite and appears to have undergone less regional metamorphism. The limestone is light gray, crystalline, and of variable texture, but generally not as coarse-grained as much of that near the cinnaabar lodes. Most of the schist seen is interbedded with the limestone, and, in several places, notably at the Copper Cliff prospect, the limestone was originally somewhat argillaceous. These schistose and impure facies of the limestone near Profile Creek may correspond to the schist and hornfels mapped near the cinnaabar deposits.

The Paleozoic rocks are crumpled and broken by minor faults, and no accurate measurement of the thickness was made. It is thought that the structure is in general anticlinal. The quartzite is probably several hundred feet thick, and the overlying limestone may be much over 1,000 feet thick.

Rocks near Two Point Lookout, in the Casto quadrangle, are similar to the rocks near Profile Creek, both in lithology and in probable age, but their stratigraphic relations to those rocks are unknown.

A small amount of quartzite lithologically similar to that near Profile Creek projects through the Casto volcanics on Coxey Creek in Sec. 17, T. 21, N., R. 12 E. It is too small to be shown in figure 2. This quartzite is tentatively regarded as a remnant of the Paleozoic strata, although it may be a variety of the Hoodoo quartzite.

Casto volcanics

The rocks mapped as Casto volcanics on figure 2 are similar both in lithology and in stratigraphic relations to the formation of the same name in the Casto quadrangle. 2 The formation is now known to extend within 50 miles of the Permian volcanic strata in the Seven Devils region, and it is probable that the Casto volcanics are of Permian age.

The greater part of the Casto volcanics in the region are dark-green, purple, red, and black andesitic lavas and flow breccias, which are generally porphyritic. Some lighter-colored flows are present near the mouth of Gardner Creek and elsewhere. Just east of the mouth of Cave Creek, in Sec. 26, T. 21, N., R. 12 E., in and near the cave from which that stream is named, there is a highly contorted latitic flow-breccia with included fragments as much as 6 feet in diameter composed of the same rock as the matrix. This latite is much fresher in appearance than the Casto volcanics around it and may represent a plug-like intrusion of Tertiary age.

Stratification is difficult to discern in many places in the Casto volcanics of this region, and, consequently, it is very difficult to determine the structure and the thickness of the formation. In a general way, the strata along Big Creek from a point near Coxey Creek east lie nearly horizontal or are inclined east at

low angles. More than 1,500 feet of strata appear to be represented. Some of the beds close to Big Creek contain fragments of quartzite, suggesting that they may be close to the base of the formation. In the smaller exposure near Dead Mule Mountain, north of Ramsey Ridge, if the average dip corresponds to the observed dips of 45° and 65° NE, the thickness would appear to be fully twice this.

Detrital blocks of rock resembling the Casto volcanics were noted on the ridge between Lower Meadows on Cottonwood Creek and the head of Hungry Creek. This suggests that the Casto volcanics may be exposed on this ridge.

Rocks related to the Idaho batholith

Classification

Most of the coarse-grained intrusive rocks in the area included in this report are related more or less closely to the Idaho batholith, which, on the basis of evidence from nearby areas 1, is probably of post-Triassic and pro-Eocene age.

Five varieties of the intrusive rock were distinguished in the field - quartz-monzonite diorite, gneissic quartz diorite, quartz diorite, quartz monzonite, and granodiorite. All the diorite rocks are older than the typical quartz monzonite and granodiorite that constitute the greater part of the Idaho batholith, but there is probably little difference in age. In addition, there are small lamprophyre, aplite, and pegmatite dikes intimately associated with and doubtless related to the rocks of the Idaho batholith. These are more abundant in and near the marginal masses of dioritic rocks than elsewhere. They are not further discussed in the present paper.

Quartz-magnetite diorite

Two of the masses of dioritic rock differ from others in the region in being somewhat more altered in general appearance and in having much less conspicuous biotite. One of these crops out over more than 8 square miles on Ramsey Ridge. A similar but somewhat finer-grained mass covers nearly a square mile at the head of one fork of Porphyry Creek, a short distance south of Mosquito Spring. The outcrops, especially on Ramsey Ridge, are characteristically rusty, in contrast to the relatively fresh exposures of most of the other intrusive rocks of the region.

The diorite of Ramsey Ridge is a dark rock, characterized by numerous black spots. Over half of the rock is made up of an altered plagioclase feldspar, near andesine in composition, in imperfectly formed crystals about an eighth of an inch long. It also contains 10 to 20 per cent of biotite and chlorite, mainly derived from the biotite, 5 to 10 per cent of quartz, 15 to 20 per cent of magnetite, and some apatite. The similar rock on Porphyry Creek is nearly black and is somewhat finer-grained. The principal component is sericitized andesine, but there is also a little potash feldspar, fully 20 per cent of quartz, about 15 per cent of partly chloritized biotite, a few per cent of magnetite, and minor amounts of apatite. Both rocks, especially that of Porphyry Creek, have been partly crushed and recrystallized, and the biotite characteristically occurs in clusters of minute flakes.

Gneissic quartz diorite

The two rock masses mapped as gneissic quartz diorite on figure 2 are characterized by a pronounced gneissic banding and by abundant inclusions of rocks of

the Belt series. Except for these two features, the gneissic rock appears to be essentially the same as the quartz diorite next to be described, and, like it, locally grades into the quartz monzonite and granodiorite that form the main mass of the batholith. In other places, however, the dioritic rocks are cut by tongues of the more siliceous rock.

The gneissic rocks have a wide range in appearance because of differences in the character and relative abundance of the inclusions. Most of it, however, is a dark-gray, mottled, distinctly granitic rock, with a rude gneissic banding. In many places there are bands or irregular schlieren of biotite, hornblende, or epidote, which are believed to represent incompletely digested inclusions. From these there are all gradations to masses of sedimentary material, mainly belonging to the Yellowjacket formation, that are so little altered as to be readily recognized. The blocks of limestone near Crooked Creek are partly silicified and epidotized, but have been relatively little invaded by the magma. Some of the impure quartzite has well developed bands of igneous material—for example, along Big Creek above Monumental Bar—and a sharp line cannot be drawn between the banded quartzite and the gneissic quartz diorite.

The gneissic quartz diorite, whose relatively fresh from foreign material, is a moderately coarse rock with feldspar and biotite grains a few millimeters in diameter. The broad spangles of biotite that are prominent features in the hand specimen serve to distinguish this rock from the quartz-monzonite diorite. Plagioclase is the principal constituent. It generally has the approximate composition of andesine, but in some places—for example, on the lower reaches of Monument Creek—the feldspar is as calcic as labradorite. There is rarely less than 20 per cent of biotite, and locally this is the most abundant constituent. Hornblende is commonly present in minor amount, but locally makes up nearly half of the dark minerals in the rock. In places there is fully 15 per cent of quartz, and this mineral is probably everywhere present interstitially. Apatite and epidote are generally present, and in places each constitutes several per cent of the rock. Alteration of the feldspar, biotite, and hornblende has been less intense than in the quartz-monzonite diorite.

Quartz diorite

The quartz diorite closely resembles and is doubtless related to the gneissic quartz diorite described above. It is a fairly fresh medium-grained, dark-gray rock composed mainly of andesine and biotite with hornblende in variable amount and quartz generally present but nowhere abundant. Apatite is a prominent minor constituent. Chlorite, epidote, and sericite are generally not abundant. The relative proportions of the various minerals are about the same as in the gneissic diorite from inclusions just described. There are local finer-grained facies in which the black minerals, mainly biotite, compose over half the rock. On the other hand, some of the rock approaches in composition the quartz monzonite described below. North of Chamberlain Creek, and especially near the point where the quartz diorite crosses that stream, there is considerable local variation in the granitic rocks, and adequate distinction in detail could not be made in the present investigation.

Quartz monzonite and granodiorite

The main mass of the Idaho batholith is made up of coarse-grained rock with somewhat gneissoid granitic texture. In composition the rock in general ranges from quartz monzonite to granodiorite, although, in places, as on the lower reaches of Big Creek, there are local facies with the composition of alkaline granite. However, such facies are minor in amount and are gradational into the monzonitic and granodioritic rocks. The prevailing quartz monzonite and granodiorite are coarse even-grained rocks whose component grains average about an eighth of an inch in diameter. In places—for example, on some of the ridges east of the South Fork of the Salmon River—the rock is studied with feldspar phenocrysts from 1 inch to several inches long. Dark minerals in general constitute less than 20 per cent of the rock. Plagioclase is the most abundant feldspar and ranges in composition from about An₂₅ to An₁₅. Microcline and orthoclase make up from 10 to almost 50 per cent of the feldspar, but generally less than 30 per cent.
Quartz is abundant and generally forms 20 to 30 per cent of the rock. Biotite ranges from 5 to 20 per cent, and in some rocks muscovite is present. Titanite is abundant, and generally small needles of apatite can be seen under the microscope. Over much of the area the rock is fairly fresh, but in the vicinity of ore deposits - for example, near Edwardsburg and Profile Gap - the biotite is partly or wholly altered to chlorite, magnetite, and epidote, and the feldspars to fine-grained clay minerals and sesquioxide-magnetite material. Within the mineralized zones near Edwardsburg and Profile Gap the quartz monzonite and granodiorite are generally sheared and granulated.

Tertiary rocks

Classification

The Tertiary rocks include (1) the Challis volcanics, which are a thick series of interbedded flows, tuffs, and agglomerates with some interbedded sedimentary rocks, (2) basalt flows and related dikes, and (3) a complicated group of intrusive rocks, mostly dikes but including also some large irregular-shaped bodies.

The Challis volcanics are of economic interest because they contain valuable ore deposits. The dikes and irregular-shaped bodies are also of economic interest because they are closely related to the Tertiary mineralization and are particularly numerous along mineralized zones in the Edwardsburg district and elsewhere. Within mineralized zones of this kind there are hundreds of the dikes, and when understood more fully they may offer a tangible approach to the solution of at least part of the structural history of the ore deposits. Hence, considerable space is given to the character and relations of the different varieties of dikes.

Challis volcanics

Main mass - A large area in the southern part of the region described in this report is underlain by volcanic strata which are co-extensive with the Challis volcanics, of probable upper Oligocene or lower Miocene age, mapped in the Casso quadrangle 1/ and other areas east and south of Thunder Mountain. 2/

The greater part of the formation is composed of flows ranging from andesite to quartz latite. Beds of nearly white tuff and rhyolitic rocks, which constitute the larger part of the upper members of the formation, are found in this region mainly in and immediately around the Thunder Mountain district. Farther west only the lower members of the formation have survived erosion. In the Thunder Mountain district and extending intermittently as far north as Tale Creek there is an aggregate thickness of wall over 1,000 feet of light-colored rhyolitic lava, flow breccia, tuff, and tuffaceous conglomerate, all containing in places fragments of charred and silicified wood and all somewhat kaolinized. In the vicinity of Rainbow Peak, a short distance west of Thunder Mountain, 2,500 to 3,000 feet of the volcanic rocks are exposed. In the vicinity of Cougar and Pinnacle peaks, near the northwestern border of the formation as now exposed, fully 2,000 feet of strata are represented.

The Challis formation in this region was originally spread widely over a surface of marked relief. The irregularity of its contacts results locally from subsequent orogenic disturbances but in large part reflects original irregular-


10.
ities in the surface on which it was laid down. That the topography at the be-

ginning of the eruptions was sufficiently accentuated to give rise to streams of
sharp gradient is shown by the presence of poorly sorted angular or subangular
pebbles and boulders of pre-Tertiary rocks near the base of the Challis volcanics
in several places. For example, a basal conglomerate of this sort rests on gran-

diorite of the Idaho batholith on the Sam Wilson property, near Profile Gap,
where it is over lain by a greenish-gray porphyritic andesite. Also there are
pebbles of granitic rock in a matrix of volcanic material on upper Monumental
Creek; boulders of granitic rock with some of quartzite in a matrix containing
variable amounts of volcanic rocks in the glacial cirques at the head of Jacobs
Ladder Creek, and angular boulders of old rocks mainly Rodeo quartzite in the
straits along lower Lick Creek south of Edwardsburg. Bell 2 notes that a specimen
from the lowest tunnel in the Dewey mine is a "breccia of slate fragments in a
matrix of quartz and feldspar", which suggests that the old rocks may be present
at a shallow depth in the vicinity of the mine.

Basalt- Basalt caps several ridges near Thunder Mountain. The largest area
forms a flat ridge, locally termed "Niggerhead", to the north of Dewey Hill.
Basalt also caps successively lower alump terraces south of Niggerhead. Two other
small bodies of basalt crop out on ridges east of Marble Creek. Both have been
displaced by landslides. A small basalt flow merges with a dike in the low saddle
a few hundred feet east of Dewey Hill. Other small patches, displaced by land-
slides, crop out a few hundred feet west of the H-Y shaft. None of these have
been separately mapped on figure 2.

The basalt is clearly later than the flow breccia, tuff, sandstone, shale,
and related rocks of the main part of the Challis volcanics exposed near Thunder
Mountain as it cuts and rests upon them. However, it may be a later facies of
the same period of volcanism.

The basalt is a very fine-grained black rock that in places has pronounced
vesicular texture. It is composed principally of a felted aggregate of plagi-
oclass, with a composition of andesine-labradorite, and partly altered ferro-
magnesian minerals. In general, the rock is fresh in appearance.

Tertiary intrusive rocks

Classification and relations

In certain parts of central Idaho, such as the Casto quadrangle 2, the
Boise Basin 3, and the region here described, there are zones in which Tertiary
dikes and irregular-shaped masses are closely spaced and very numerous. In some
of these zones the dikes are closely associated with ore deposits. Only two
small masses of Tertiary intrusive rock were mapped during the reconnaissance of
the eastern division of the Idaho National Forest. They are the one on Cave
Creek, mainly in Sec. 3, T. 21 N., R. 12 E., which is composed principally of
coarse pink granite, and the mass of pink granophyre at the junction of Cougar
and Big creeks. Parts of the much larger masses of similar rock in the Casto
quadrangle are shown in the southeast corner of figure 2.

1 Bell, R. N., Geology of Thunder Mountain and central Idaho: Eng. and Min. Jour.,
vol. 78, pp. 791-793, June 7, 1902.
2 Ross, C. F., Geology and ore deposits of the Casto quadrangle, Idaho: U. S.
Geol. Survey Bull. 824, pp. 54-68, 1934.
3 Ross, C. F., Some lode deposits in the northwestern part of the Boise Basin:
The principal zone of dikes extends northward from a point near Profile Gap past Elk Summit to the ridge at the head of Wolf Fang Creek. Part of this zone is shown in detail in figures 3 and 4. Similar dikes continue from Wolf Fang Creek northward at least as far as Sheepsteer Peak. Such dikes are abundant near Dead Mule Mountain and are prominent, though less closely spaced, on Ramsey Ridge and in the valley of Big Creek south of that ridge. Similar dikes with northward trends crop out along the Salmon River near Campbell's Ferry, and Livingston and Stewart had described many dikes near Dixie, north of the Salmon River. Closely spaced dikes also crop out in an area of several square miles near and south of Middle Meadows on Cottonwood Creek.

The Tertiary intrusive rocks in the region here described include pink granite and granophyre, granodiorite, quartz diorite, dacite, andesite, and quartz latite porphyry, rhyolite porphyry, diorite, several types of lamprophyre, and basalt dikes that cut the Challis volcanics and in places near Thunder Mountain grade into flows. The pink granite and granophyre, the quartz diorite and granodiorite, and the porphyritic dikes and lamprophyres cut the Idaho batholith. Ross found igneous rocks related to the pink granite, especially granophyre dikes, intruded into the lower part of the Challis volcanics. He found Tertiary quartz monzonite, quartz diorite, and dacite porphyry cutting pink granite, but he also found a pink granophyre cutting dacite porphyry. Near Profile Gap dikes of quartz latite porphyry cut Tertiary quartz diorite and Challis volcanics. Dikes of rhyolite porphyry cut dikes of quartz latite porphyry, quartz diorite, and granodiorite. Some lamprophyre dikes cut diorite, but others appear to grade into diorite. Although these relations indicate that the lamprophyric rocks here described are Tertiary, there is reason to believe that closely similar rocks elsewhere in this part of Idaho are related to the Idaho batholith. It is probable that some of the lamprophyre within the region shown on figure 2 is of the latter kind.

Pink granite

The pink granite is pale pink and of variable but coarse grain. A sample of the granite from the Castle quadrangle described by Ross contained 28 per cent of quartz, 45 per cent of microcline-microperthite, 15 per cent of oligoclase-andesine, 7 per cent of biotite, 3 per cent of hornblende, and small amounts of magnetite and epidote. The feldspars were slightly microcrystalline, and a little calcite and epidote were present in places. Other parts of the pink granite contained more quartz, some nearly 80 per cent, and many specimens contained no hornblende and some almost no biotite. Ross also describes several other varieties of the pink granite, one a fine-grained facies composed mainly of microperthite and another a plagioclase-rich variety that approximates quartz monzonite in composition.

Pink granophyre

The typical pink granophyre is pale pinkish cinnamon-brown and weathers to buff, but some varieties have a brownish tone. The rock consists of phenocrysts (10 to 25 per cent) of quartz, feldspar, and biotite enclosed in and


\[\text{Ross, C. P., Idaho, p. 55.}\]

\[\text{Ross, C. P., op. cit., p. 64.}\]

12.
GEOLOGIC MAP OF THE PROFILE GAP AREA, VALLEY COUNTY, IDAHO

EXPLANATION

Quaternary

Lamprophyre

Quartz diorite

Chalico volcanics

Tertiary

Idaho batholith

Principal igneous rocks

Principal limestone

Principal argillite

Principal quartzite

Quartz diorite

Granodiorite

Rhyolite

Quartz latite porphyry

Silicified and mineralized rhyolite and quartz-latite porphyry

Pleistocene

Recent alluvium

Till

Moraine

MINES AND PROSPECTS

@ Red metal

@ Profile - Yellow Pine

@ Sam Wilson

@ Lotsplech
corroded by an aphanitic groundmass of micropegmatite. Round phenocrysts of quartz and rectangular phenocrysts of feldspar as much as 5 millimeters in length are about equally abundant. Microcline, considerably sericitized, is commonly more abundant than plagioclase (albite-oligoclase). Biotite, partly chloritized, is scarce. The groundmass varies in detail. It is commonly a typical graphic intergrowth, but in some dikes it consists of radial aggregates, some of which are well-defined spherulites visible to the unaided eye.

Granodiorite and quartz diorite

Bodies of Tertiary granodiorite and quartz diorite occur as irregular masses and as dikes cutting rocks of the Idaho batholith. Both are practically free from hydrothermal alteration and shearing, whereas the rocks of the Idaho batholith which they intrude are much sheared and greatly altered. Because the granodiorite and quartz diorite here described cut rocks of the Idaho batholith, because of the more intense shearing and alteration in the rocks of the batholith, and because the granodiorite and quartz diorite appear to have invaded the same zones of shearing in the batholith as the dikes of known Tertiary age, the granodiorite and quartz diorite are tentatively classed with the Tertiary rocks.

The Tertiary granodiorite is well exposed a few hundred feet west of Crater Lake, near Profile Gap. It is a coarse-grained rock in which the light colored minerals exceed the dark minerals. It resembles some unaltered varieties of the Idaho batholith, but does not have the foliated structure so commonly developed in the rocks of the batholith. The average grain size of the granodiorite is about 1.5 millimeters. The plagioclase has marked zoning, but has an average composition of about Ab34. It commonly makes up about 60 per cent of the rock. Orthoclase makes up about 20 per cent, quartz 13 per cent, biotite 7 per cent, and hornblende less than 1 per cent. Small amounts of apatite, magnesite, and ilmenite are present. The granodiorite is usually almost free from alteration, although in some places biotite is slightly altered to chlorite and epidote.

The larger masses of Tertiary quartz diorite are even-grained, but the smaller dikes-like bodies are porphyritic. Dark-colored inclusions are numerous in the even-grained rock. The average feldspar grain is about 0.25 by 0.4 millimeter in cross section. Small interstitial quartz grains, which are abundant, have an average diameter of about 0.08 millimeter. The plagioclase, which is much zoned and has an average composition of approximately Ab35, makes up about 65 per cent of the rock, orthoclase makes up about 8 per cent, quartz 15 per cent, biotite 8 per cent, and hornblende 4 per cent. Apatite, magnesite, and ilmenite together constitute less than 1 per cent of the rock. In general, alteration products are not abundant. Biotite is as a rule partly altered to chlorite and epidote, and the feldspars commonly contain some fine-grained sausuritic material. The porphyritic varieties are similar in composition to the even-grained varieties. The phenocrysts in the porphyritic varieties make up about 40 per cent of the rock.

Dacite, andesite, and quartz latite porphyries

Many closely related dikes ranging in composition from quartz latite to andesite are widely distributed in south-central Idaho. Ross 1 has grouped these rocks for descriptive purposes under the term "dacite porphyry", whereas Currier 2 describes them as "porphyritic andesites and dacites". Near Edwardsburg the composition of these dikes more clearly approaches that of quartz latite.

Both Ross and Currier recognized that the composition of the rocks described as dacites, andesites, and quartz latites, differs from place to place, but they also recognized that the resemblances are greater and more fundamental than the differences and hence classed them in the same group.

The rocks of this group cut the granitic rocks of the Idaho batholith, the Challis volcanics, and the Tertiary quartz monzonite and quartz diorite. In places the intrusive patterns of the dikes are very intricate. For example, near Profile Gap the pattern is considerably more complex than could be shown on the scales used in figures 3 and 4. Ross found these dikes in similar complex patterns in the Casto quadrangle.1

The dacite, andesite, and quartz latite porphyries are similar in appearance. When fresh they are greenish-gray rocks with large phenocrysts of white or pinkish feldspar and smaller ones of black biotite in a dense groundmass. In the dacite and quartz latite porphyry dikes glassy-appearing quartz phenocrysts are abundant. The feldspar phenocrysts commonly exceed 5 millimeters in length, but the biotite and quartz do not exceed 3 millimeters. The groundmass, which generally makes up from 50 to 60 per cent of the rock, is composed of a mass of indistinct mineral grains generally less than 0.01 millimeter across.

The feldspar phenocrysts are chiefly andesine and orthoclase. In the dacite and andesite porphyries orthoclase is subordinate, but in a typical sample of quartz latite porphyry from Elison Creek andesine (An50) makes up about 45 per cent of the phenocrysts, orthoclase about 30 per cent, quartz about 15 per cent, and biotite about 10 per cent. Magnetite, apatite, and ilmenite make up less than 1 per cent of the rock.

In most places the rocks of this group are considerably altered. Biotite is commonly almost completely changed to chlorite, epidote, and calcite. Orthoclase is in general partly altered to clay minerals, and the andesine, although less altered than orthoclase, generally is partly changed to a saussuritic product and in many places contains calcite and sericite. In some places near Profile Gap quartz latite porphyry is almost completely altered to a dense white rock with glassy-appearing quartz phenocrysts and brown specks of iron oxide. Except for the rather abundant large quartz phenocrysts, this altered rock looks much like the altered rhyolite dikes. Some of the quartz latite porphyry dikes near the southwest corner of the Copper King No. 1 patented mining claim of the Profile-Yellow Pine Company near Profile Gap are almost entirely replaced by fine-grained quartz which in places displays vuggy structure. Some pyrite and its alteration products are associated with the quartz. A small sample of this material, from a point 200 feet southwest of the southeast corner of the Copper King No. 1 claim, assayed in the chemical laboratory of the United States Geological Survey, contained neither gold nor silver, although some material of this type is said to contain gold in small amounts.

Rhyolite porphyry

Rhyolite porphyry occurs as dikes cutting granitic rocks of the Idaho batholith, the Tertiary quartz diorite and granodiorite, and quartz latite porphyry. It is cut in turn by lamprophyre dikes. The rhyolite dikes are considerably altered, and near Profile Gap nearly all contain pyrite. Currier2 reports that

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1Ross, C. P., op. cit., p. 62.
2Currier, L. W., op. cit., p. 13.
Figure 4. Map showing relations of dike and veins in the vicinity of the Glasgow claim of the Profile-Yellow Pine Company, Profile Gap.
the rhyolite dikes at the Fern, Hermes, and Meadow Creek mines are also greatly altered and that one at the Meadow Creek mine contains specks of pyrite and stibnite. Because of the intense silicification and the presence in the dikes of pyrite and stibnite, the rhyolite porphyry was probably intruded at least before the last period of mineralization ended.

The microscope shows that even the fresher-appearing rhyolite is considerably altered. The rock is fine-grained, and has a distinctly porphyritic texture, although this texture is not nearly as pronounced as in the dacite and latite porphyries.

In the fresher rocks there are abundant phenocrysts of orthoclase, sodic plagioclase, and biotite in a dense groundmass. In the less altered rocks remnants of original hornblende remain. The larger feldspar grains of a typical rhyolite near Profile Gap averaged 0.77 by 0.37 millimeter in cross section, but Currier reports that some orthoclase phenocrysts in a dike at the Fern mine are as large as 5 centimeters. The plagioclase feldspars in the rhyolite near Profile Gap are considerably zoned, but even the central zones are more sodic than An50. The amount of quartz differs in different places. Some quartz phenocrysts are usually present, but in general quartz is not conspicuous as such but occurs rather as myrmekitic intergrowths. The feldspars have been altered to sericite and a clay mineral of the montmorillonite type. The ferromagnesian minerals have been altered to chlorite and calcite, and, in places, to epidote. In the surface exposures of the more altered rhyolitic rocks pyrite and its alteration products have been removed, and only calcite remains.

Diorite

Diorite occurs in the Edwardsburg district as dike-like bodies in close association with some of the lamprophyre dikes. It is a massive medium-grained dark rock in which the dark minerals exceed the light-colored ones. Plagioclase is the most abundant mineral. The crystals are lath-shaped and have an average cross section of about 0.2 by 0.5 millimeter. The rock is everywhere greatly altered, but the less altered parts of the feldspars have a composition of about An55. Orthoclase was not recognized and only a small amount of quartz is present. Except for some remnants of biotite, the ferromagnesian minerals are changed to chlorite and calcite. Magnetite and ilmenite, partly altered to leucoxene, are scattered through the rock. Chlorite makes up about 30 to 40 per cent of the average diorite, and calcite about 20 per cent. Pyrite and some of the calcite appear to have been introduced.

Lamprophyre dikes

Lamprophyre dikes are widespread, but they are particularly abundant in the mineralized zones of the Edwardsburg district (figs. 3 and 4). They cut quartz diorite, granodiorite, quartz latite porphyry, rhyolite, and some quartz veins — for example, at the Wendenhoff mine and on the Glasgow claim of the Profile Yellow Pine Company. Field relations indicate also that some of the lamprophyre dikes cut other lamprophyres of similar appearance. However, except where the crosscutting relations are plainly evident, the dikes could not be separated in the field because of their similarity in appearance. Lamprophyre dikes definitely cut a diorite dike just west of the Glasgow claim, whereas in some other places — for example, about 2700 feet S. 15° W. from the bunkhouse of the Red Metal mine or Ellison Creek — diorite appears to grade into fine-grained lamprophyre. This

\[\text{Currier, L. W., op. cit., p. 13.}\]
same sort of gradation is also shown near the southwest corner of the Glasgow claim, where lamprophyre dikes appear to "sprout" from the diorite; hence, it is believed that the diorite and lamprophyre dikes are closely related genetically.

Most of the lamprophyre dikes in the Edwardsburg district are greatly altered, but the fresher ones can be classed as kersantites or spessartites, depending upon the relative amounts of biotite and hornblende. All are fine to medium-grained, dark-gray to nearly black rocks that are characterized by well-formed, lath-shaped plagioclase crystals. The plagioclase crystals range from 0.03 by 0.15 to 0.65 by 0.3 millimeter in cross section in most of the lamprophyres, although in some a few scattered phenocrysts exceed those dimensions. Some dikes contain white nodules of calcite and a zeolite similar to heulandite that exceed 5 millimeters in diameter. The composition of the feldspars ranges from about An45 to An80, but the more sodic compositions prevail. In the less altered lamprophyres the plagioclase constitutes from 60 to 65 per cent of the rock. Very little orthoclase was recognized. Some quartz is present in nearly all the lamprophyre dikes. Biotite and hornblende normally make up about 15 per cent of the rocks. Biotite prevails in some, and hornblende in others, but in the fresher rocks both are commonly present. Both are generally of about the same shade of brown. The hornblende tends to form long tabular crystals; the biotite is more nearly equidimensional. The biotite is more resistant to alteration than hornblende and is present where only ghost outlines of hornblende remain. Fine-grained magnetite dust commonly outlines the original shape of the hornblende where it is completely decomposed. Magnetite and ilmenite are generally abundant and in some lamprophyres make up 5 or 7 per cent of the rock. In some of the dikes ilmenite occurs as small oriented needles. Tiny needles ofapatite are also abundantly scattered through the dikes.

Some of the lamprophyres in the Edwardsburg district contain pyrite. Calcite, siderite, chlorite, epidote, saussurite, and leucoxene are the most abundant alteration products. In some of the more altered rocks these products constitute more than 50 per cent of the minerals, and calcite alone commonly exceeds 30 per cent.

Quaternary rocks

Classification

The Quaternary deposits include material of glacial and landslide origin and stream deposits. The glacial deposits are of probable Pleistocene age, and the landslide material has been formed at different times since the middle Tertiary. Streams are depositing material today, and terraces high on some valley walls indicate that some of the stream deposits antedate the last period of glaciation.

Glacial deposits

Considerable areas in central Idaho were glaciated in the Pleistocene epoch. As the glaciers moved down the valleys they carried a great deal of rock material with them and ultimately deposited it in the valleys below. Some of this material has since been reworked by streams, but in many places the deposits still retain their morainal characteristics. Morainal deposits occur near the heads of Big Creek, Monumental Creek, Smith Creek, and almost every other large stream in the region. Some of the partly reworked glacial material has been tested for gold, and most of the gravel worked as placer ground on Smith Creek is of glacial origin.
Figure 8. Landslide scarp on west front of Thunder Mountain.
There are many landslide deposits throughout the area underlain by the Challis volcanics, and in some areas underlain by older rocks. These deposits are especially numerous near Thunder Mountain. For example, almost the entire west side of Monumental Valley from Anne Creek to Mule Creek has been affected by landslides. Many landslides have also occurred on the east side of Monumental Creek and on both slopes to Marble Creek. In general, the landslide deposits have formed in two ways - by movement as large blocks and by flowage of plastic material down hillsides or valleys.

The landslide deposits in which the rocks moved essentially as blocks are more numerous than those formed by flowage of plastic material. A landslide block on the north slope of Rainbow Creek near its mouth is illustrated in figure 5. The rocks in the displaced blocks are usually tilted and considerably fractured and in places greatly shattered. The deposits formed by the movements of plastic material are commonly termed "mud flows", as the material actually moved by flowage (solifluction). Mud-flow material covers much of the area at the heads of Mule and Coone creeks. In places it is very thick - for example, at the E-Y mine where a shaft was sunk 200 feet in mud without reaching solid rock. A relatively recent mud flow is well illustrated by the Mule Creek flow of 1909. This landslide, which left scarps over 30 feet high where it broke away from older landslide material, flowed down the narrow canyon of Mule Creek at a rate of 8 to 10 feet a minute and spread out to form a fan-shaped deposit at the mouth of Mule Creek (figs. 6 and 16). This fan spread across Monumental Valley and dammed the creek, forming the lake that flooded the town of Roosevelt. The mud flow is composed of unsorted muddy material with numerous large and small boulders of flow breccia, surf, basalt, sandstone, shale, and related rocks, fragments of trees, and abundant carbonized wood. The muddy material and carbonized wood were largely derived from the clay and tuffaceous beds at the head of Mule Creek, which becomes very plastic when saturated with water.

On the north side of Mule Creek, near its mouth, there is a deposit of detritus like the mud flow of 1909, apparently too high above the stream to be recent flood-plain material. Buildings erected before 1909 stand on it, and it probably represents an old mud flow.

The lake that now covers the town of Roosevelt is being filled with silt at a fairly rapid rate. The flat that the town was built on probably represents an older silted basin that was formed like the one that is being filled today. At one time Monumental Creek near the mouth of Meadow Creek, over 5 miles below Roosevelt, was filled to a height of a few hundred feet above the present stream, possibly as the result of a landslide dam. Most of the detritus has been eroded away, leaving only a few pinnacolo-like remnants, each surmounted by a protecting boulder. The largest of the pinnacles, which gives the name to Monumental Creek, is shown in figure 7.

Structure

Folding

The exposures of the stratified rocks are so fragmentary that little information as to folding is available. Field work was not carried south of Tamracreek Creek, and data on the folding of the Paleozoic beds are consequently incomplete. The two structure sections in figure 2 show the probable conditions

1/ McCrea, D. C., personal communication.

17.
Figure 6. Dewey Hill surrounded by mud-flow material (white). The terraces in the left background above Dewey mine camp were formed by slumping. The stream channel lined with mud-flow material is Mule Creek.
in somewhat diagrammatic fashion. The Belt and Paleozoic rocks form separate anticlinal areas with decided crumpling in the more incompetent members. Both folds trend northwest, but there is no clue to show whether or not the folding of the two groups of rocks was related. The anticline involving the Belt rocks trends about N. 50° W. Local crenulation, perhaps accompanied by faulting, brought the Hoodoo quartzite into a relatively low position on the east side of lower Monumental Creek. Projected along its strike the anticline would fall southwest of the broken syncline in similar rocks in the northeast corner of the Casto quadrangle. These two isolated remnants of Belt strata are thus broadly accordant in structure. In both places the Casto volcanics, themselves distinctly folded, rest unconformably on the edges of the Belt strata. In the region here discussed this is indicated by the overlapping of the Casto volcanics on both the Hoodoo and Yellow-jacket formations in the vicinity of Dead Mule Mountain. The Challis volcanics in the northern part of the Idaho National Forest lie nearly flat and do not come into contact with the Casto volcanics, but studies to the southeast have shown that they are broadly flexed and lie unconformably on the Casto rocks. In and near the Thunder Mountain district the Challis volcanics have been gently flexed and broken by numerous faults and landslides. Some of the flows probably had initial dips of several degrees. The observed dips on the Monumental Creek side of Thunder Mountain are westerly, whereas most of those on the Marble Creek side are easterly. Few dips exceed 25°, and the strata probably are essentially horizontal over considerable areas. The average strike of the folding appears to be somewhat north of west. Thus, three periods of folding of diminishing intensity are recorded in the region.

Faulting

Faulting occurred in this region both before and after the formation of the ore deposits. The principal mineralization in the Edwordsburg district is in large northward-trending shear zones, probably formed by extensive fault movements, in pre-Tertiary rocks. Other faults in the described area trend N. 40° - 50° W., approximately parallel to the folding in the pre-Tertiary rocks, but movements have occurred along them in relatively recent time, because the Challis volcanics have been displaced. Only two faults have been plotted on figure 2, but two smaller faults of similar attitude were noted in the Thunder Mountain district, and minor faults of various attitudes are locally common. It is probable that more detailed work over larger areas would disclose others as persistent as the two mapped. The attitude of the patch of Hoodoo quartzite capping the ridge between Smith and Beaver creeks suggests that a fault similar to that mapped on Smith Creek may exist on Beaver Creek.

ORE DEPOSITS

History and production

The first mining in the area described dates back to the early sixties, but little was done until 1896 when the Caswell brothers and A. O. Huntley discovered gold in the soft material on the surface of the deposit now known as the Dewey mine. Exaggerated accounts of the richness of the new gold district were widely circulated, and as a result several thousand people rushed to the new diggings. Towns were established at Belcaco and Roosevelt (fig. 16), and the vast piles of cordwood and boxed equipment in the vicinity of the mill at Belcaco testify to the ambitious plans of its founders. A wagon road was built from Cascade to Thunder Mountain, but it was little more than a trail and is no longer in use. Roosevelt was the principal business center in the district and from 1903 to 1907, while the Dewey mine was in active operation, contained from 200 to 500 people.
Figure 7. The monument for which Monumental Creek is named, Valley County.
A remnant of detritus that formerly choked the valley of the stream in the vicinity of the mouth of Milk Creek.
Claims were staked and prospect holes were dug over an area of about 30 square miles surrounding the original discovery. Many of these holes appear to have been dug at random, and most of them were soon abandoned. In May, 1909, the town of Roosevelt was flooded and abandoned as a result of a landslide that came down Male Creek. This disaster completed the discouragement of most of those who still lingered in the district. Since 1909 the only work on the Dewey mine has been done by lessees who from time to time placered dumps or dug out rich stringers. More recently, D. C. McCrea, Robert McCrea, and R. A. Davis have successfully operated the Sunnyside mine. They have built a 10-stamp mill with a flotation unit and have done considerable underground development work.

The total production of the Thunder Mountain district is estimated at about $350,000, most of which came from the Dewey mine.

Most of the mineral deposits in the Edwardsburg and Yellow Pine districts were located during the Thunder Mountain boom, and much of the existing development work was done at that time, but when the boom collapsed most of the activity in these regions also terminated. Since 1930, owing to new roads and the higher price of gold, several of these deposits have been reopened, and at least two, the Meadow Creek and Golden Hand mines, have had a considerable production.

Kinds of deposits

Broadly there are four kinds of mineral deposits in the region described in this report - (1) gold lodes (including those containing antimony), (2) copper deposits, (3) gold placers, and (4) quicksilver deposits. The gold lodes may be subdivided into lodes in pre-Tertiary rocks and lodes in Tertiary rocks. All the copper and quicksilver deposits are in pre-Tertiary rocks.

The gold-antimony and quicksilver deposits in pre-Tertiary rocks near Stibnite, in the Yellow Pine district, have been described by Currier and others and, hence, are not discussed in this report, although the locations of the mines are shown on figure 2.

Age of the deposits

The gold deposits of the Thunder Mountain district are in Challis volcanics, which are not younger than early Miocene. Those in the Edwardsburg district are so related to Tertiary dikes that it seems clear that they are also of Tertiary age. Near Profile Gap, for example, on the Glasgow claim of the Profile-Yellow Pine Company, gold-bearing quartz veins cut dikes of quartz latite porphyry. Similar dikes cut the Challis volcanics. In some places quartz veins are cut by lamprophyre dikes, which belong to a group of intrusive rocks regarded as of Miocene age. Similar appearing dikes cutting quartz veins in the nearby Warren district are believed by Reed to be not younger than middle Miocene. Therefore, the age of the gold-bearing lodes in the Edwardsburg district and at Thunder Mountain appears to be Miocene.


3/ Reed, J. C., personal communication.
Some of the copper deposits also appear to be of Tertiary age. Small contact-metamorphic deposits containing magnetite, chalcopyrite, and pyrite occur on the Combination group, south of Profile Gap, where they are in places partly contained in Tertiary dikes of quartz latite porphyry. Other contact-metamorphic deposits appear to be related to the Idaho batholith. No direct evidence bearing on the age of the Copper Camp type of veins was obtained.

Gold deposits in pre-Tertiary rocks

General features

The gold deposits in pre-Tertiary rocks are essentially of two classes - large, mineralized, shear zones with relatively small amounts of gold, and quartz veins with shoots that commonly contain considerable gold and appreciable amounts of silver.

The large, mineralized, shear-zone deposits are best developed in the Edwardsburg district, where they are closely associated with hundreds of dikes that extend at least from Profile Gap to the Independence mine, a distance of over 7 miles. The mineralization is not uniform and does not appear to be continuous throughout the 7 miles, but in places the outcrops can be followed continuously on the surface for more than 2 miles. The mineralized zones range from scores of feet to 200 or 300 feet in width. They trend in general northward, and the banding in them dips steeply east or west.

The shear-zone deposits occur in both the granitic rocks of the Idaho batholith and in the Belt series, and such structural and textural differences as exist have resulted mainly from differences in the country rock. In general, the country rock, whether granitic or sedimentary, is silicified, bleached, and sericitized for considerable distances on both sides of the main zone of shearing. The silicified zones are cut throughout by a large number of small quartz veins.

The gold is associated with considerable disseminated pyrite, in places stibnite, and small amounts of sphalerite, galena, chalcopyrite, fluorite, tetrahedrite, arsenopyrite, and molybdenite. The sulphides are usually almost free from oxidation at the surface, but where stibnite and chalcopyrite are present some stibiconite and kermesite have usually formed from the stibnite, and malachite from the chalcopyrite. The gold content is highest where the mineralized zones are cut by small veins containing very fine-grained, bluish-white quartz. Enrichment of the gold by solution and redeposition has not been an important process in the mineralization of the shear-zone deposits. However, in some places - for example, in the glory hole of the Moscow mine - the ore was partly oxidized and may have been somewhat enriched by surface processes.

So far as can be judged from present development, the principal asset of the large mineralized shear zones is siliceous gold ore, only partly free-milling, which ranges in gold content from 0.05 ounce or less to about 0.25 ounce to the ton. Some of the lodes contain sufficient quantities of other elements, such as copper in the Werdonhoff, fluorite in the Independence and Golden Way Up, and antimony near Profile Gap, to be of possible value as by-products. Sample shipments have been made from several of the properties on mineralized shear zones, and ore from the Moscow was treated in a small mill, but thus far no property has produced on a large scale and none has been much developed.

Gold-bearing quartz veins in granodiorite, quartzite, and argillite are numerous in the Edwardsburg and nearby districts. Many Tertiary dikes of several types occur near the veins, and some of the dikes are mineralized, although less so than the older rocks. The veins have strikes that range from north near
Profile Gap to nearly east on Ramsey Ridge. The quartz in the veins ranges from less than 1 foot to over 10 feet in thickness, but most veins average less than 3 feet. In general, the better grade ore occurs in shoots within the quartz veins. Some veins contain considerable quantities of sulphides, but they are valuable chiefly for their gold and silver content. The more common sulphides in the veins are pyrite, sphalerite, galena, chalcopyrite, and tetrahedrite. Chalcocite, bornite, and pyrrhotite are less abundant. Free gold can sometimes be seen. The sulphides are usually partly oxidized for a few feet below the surface. Iron oxides and malachite are the most common oxidation products. The gold content of the quartz veins ranges from almost nothing to over 5 ounces to the ton. Assays indicate that considerable portions of several veins contain over half an ounce of gold to the ton. The silver content is generally low, although small bodies of high-grade silver ore have been mined. For example, the Cleveland mine, long abandoned, is reported to have shipped small lots of very high-grade silver ore in the early days, and ore containing considerable silver was shipped by parcel post from the Red Metal and Dixie, although the ores from these properties are valuable principally for their gold content.

Origin of the deposits in pre-Tertiary rocks

With the exception of the contact-metamorphic deposits and magnetite veins containing copper, all the lodes in pre-Tertiary rocks here described resemble each other in many respects. They are for the most part assemblages of pyrite and gold with quartz, accompanied by various amounts of sphalerite, galena, chalcopyrite, stibnite, tetrahedrite, arsenopyrite, and molybdenite. The relative proportions of the sulphides vary greatly; at one place the ore may be principally a lead ore, and at another place stibnite or sphalerite may be abundant. Glistening white quartz of a type generally associated with deposits formed at rather high temperatures is a common gangue mineral.

Deposition took place by a combination of replacement and fissure-filling, and was accompanied by sericitization and other alteration in the wall rocks. That the alteration and replacement of the wall rocks preceded at least part of the fissure-filling is shown by numerous small quartz veins that cut the mineralized zones.

Many of the lodes are in granitic rocks of the Idaho batholith and therefore must have been formed after the batholith solidified. Both quartz veins and large mineralized shear zones appear to be at least in part younger than most of the Tertiary dikes. In some places quartz veins cut dikes of quartz latite porphyry, and in other places similar dikes appear to have been affected by the alteration and replacement attendant on the mineralization of the large shear zones. On the other hand, some lamprophyres cut quartz veins, and others are intruded at least before mineralization ceased, as they contain small amounts of disseminated pyrite. Most of the lamprophyres, however, are practically free from the effects of mineralizing processes. The Tertiary dikes appear to have had a close relation to the mineralization. Hundreds of them occur in mineralized areas. Most of the dikes trend parallel to the mineralized zones, but some trend at wide angles to it. Both the dikes and the solutions that caused the mineralization apparently moved upward along planes of intense shearing.

The distribution of the ore deposits near Edwarsburg and Thunder Mountain does not appear to correspond to the ideal zonal succession postulated by Emmens 1/ and Spurr 2/. Most of the more common metals are present in varying

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21.
amounts, but the distribution does not appear to fit a well-defined zonal arrange-
ment. This may be due to the fact that deposits of two different ages are super-
imposed and also to the fact that even during the later (Miocene) epoch of mineral-
ization there were definite interruptions and resurgences, so that some minerals
overlap.

Distribution of the deposits in pre-Tertiary rocks

Mines and prospects on gold-bearing shear zones and quartz veins in pre-
Tertiary rocks are distributed from a point south of Profile Gap to the northern
limit of the mapped area (fig. 2). For descriptive purposes they may be divided
into three groups — those in the area that extends northward from the vicinity of
Profile Gap to Beaver Creek, which will be referred to as the Edwardsburg district;
those in the area that extends eastward from Ramsey Ridge to Crooked Creek, which
will be referred to as the gold deposits near Ramsey Ridge; and those of Chamberlain
Basin.

The deposits of the Edwardsburg district are described in order from south to
north; those near Ramsey Ridge and in Chamberlain Basin are described in order from
west to east.

Gold deposits of the Edwardsburg district

Combination:— The Combination group includes several claims on Ellison Creek
southeast of the Red Metal (fig. 3). The recently completed Edwardsburg road
passes within a few hundred feet of the property.

Two types of deposits are found on the Combination claims — sulphide ore in
white quartzite, and magnetite deposits in argillite and limestone. An open cut,
a tunnel less than 50 feet long, and a shallow shaft explore a deposit of the first
type on Ellison Creek about 600 feet above the Combination cabin. Here a small
body of vitreous white quartzite projects through a moraine. It strikes N. 10° W,
and dips 35° NE. About 1 foot of sulphide ore cuts the quartzite near the bottom
of the open cut. The footwall of the ore is not exposed. The ore minerals are
sphalerite, chalcopyrite, pyrite, galena, and chalcocite.

Deposits of the second type have been explored by shallow workings in several
places. About 1,800 feet S. 38° E. of the Red Metal bunkhouse a small outcrop of
dark colored argillite is exposed through the moraine. In places it contains
bodies of dark silicate minerals, magnetite, and pyrite. A lower tunnel under one of
these mineralized bodies was not accessible in 1934. Some work has been done
on a similar deposit about 1,800 feet S. 35° W. from the Combination cabin. Here
magnetite, chalcopyrite, and pyrite occur in dark schistose argillite and grano-
diorite. Some limestone on one of the dumps contains garnet. About 50 feet above
the main workings a small body of magnetite occurs in limestone. It strikes N.
30° W. and dips 65° W.

Red Metal:— The Red Metal property is on Ellison Creek, about a mile by trail
from the Edwardsburg road. It was located and owned for many years by A. C.
Ellison, who shipped most of the ore produced. In recent years the property has
been operated by the Amalgamated Red Metal Mines Company, which controls 11 un-
patented claims and 5 fractions.1


22.
Figure 8. Upper workings of the Red Metal mine.
The Red Metal ore body is developed by three tunnels. The upper and intermediate tunnels are connected by a stope, and the lower tunnel is a crosscut 365 feet long, which was run from the mill northward under the ore body that was mined from the upper levels. This tunnel is 42 feet below the intermediate level and 74 feet below the upper level. A short tunnel has been driven on the Jumbo vein, which is about 700 feet west of the Red Metal.

Granodiorite is the prevailing rock at the Red Metal. It includes blocks of dark argillite and white quartzite, and is cut by dikes of quartz latite porphyry and lamprophyre. A stockwork of lamprophyre dikes cuts the granodiorite and other rocks about 300 feet west of the Red Metal workings. The ore came from a lens-like deposit at the contact of granodiorite and quartz latite porphyry (Fig. 3). The trend of the deposit is slightly east of north, and the dip 35° - 47° E. The hanging wall is marked by gray gouge, in most places from 1 to 2 inches thick. A fault 2 to 3 feet wide with a vertical dip runs close to the ore and terminates it on the south. The granodiorite next to the quartz is bleached, and in places the quartz latite porphyry is silicified to a dense cherty-appearing rock.

The ore is valuable chiefly for its gold content. The gold is associated with abundant galena and light-colored sphalerite, and with lesser amounts of tetrahedrite and chalcopyrite. Pyrite is present in small amounts. Sulphides occur unaltered close to the surface. The gold and silver content of the ore shipped from the Red Metal ore body is not known, but it must have been of good grade, because much of it was shipped by parcel post.

The Jumbo vein is a mineralized shear zone in schistose argillite and limestone. Two lamprophyre sills occur in the argillite close to the tunnel. The vein strikes N. 30° E. and is nearly vertical, whereas the schistosity of the wall rocks, although nearly vertical, strikes N. 40° E. Considerable epidote has formed in the more limy beds near the ore body. The ore is about 8 inches wide where exposed and consists of chalcopyrite, and its oxidation products in a gangue of sheared argillite with very little quartz.

Profile-Yellow Pine:- The Profile-Yellow Pine Company has 9 patented and 2 unpatented claims 1, which extend from Ellison Creek on the south almost to Profile Gap on the north. Practically all the underground work has been done on the Glasgow, a patented claim. The workings consist of two inclined shafts, a tunnel 410 feet long, and numerous open cuts.

The bedrock in the vicinity of the Glasgow claim is granodiorite of the Idaho batholith, containing many bodies of limestone, quartzite, and argillite, the Challis volcanics, and many dikes that cut them (fig. 4). In places the bedrock is covered by glacial moraine and alluvium. Quartz veins cut granodiorite and considerable pyrite and chalcopyrite are disseminated through schistose argillite about 150 feet west of the Glasgow claim. The most persistent quartz veins trend on an average about N. 10° E. and dip at steep angles to the west. Less persistent veins strike N. 30° - 35° E. Except in the Don Pedro claim, the quartz in any one vein cannot be traced more than a few hundred feet, and generally not as much as 100 feet. In the Don Pedro, it is continuous for about 900 feet. The vein quartz ranges in width from less than 1 inch to 20 feet, but probably averages less than 1 foot. For much of its extent the Don Pedro vein is at the base of a scarp about 20 feet high that was probably formed by faulting. The quartz is about 8 inches wide near the top of the new Don Pedro shaft, but alternately widens and narrows in depth. In the shaft the quartz, which is

Figure 9. Glasgow tunnel, Profile Gap

Granodiorite, considerably silicified

4 feet of intensely silicified granodiorite. No sulphides

Fresh lamprophyre dike

1-foot white gouge

Dark porphyritic granodiorite

Granodiorite, considerably silicified

Granodiorite, considerably silicified

4 feet intensely silicified granodiorite

6 inch fresh lamprophyre dike

6 inches quartz

12 inch altered lamprophyre dike

3 feet of shattering

EXPLANATION

Granodiorite

Lamprophyre dike

Quartz

Gouge

6 inches to 8 inches quartz. Some disseminated sulphides. A little malachite

Granodiorite, considerably silicified

2 inch gouge

Intensely silicified rock with disseminated sulphides, mostly pyrite

Granodiorite, considerably silicified

Granodiorite, considerably silicified

Granodiorite, silicified. Some pyrite

4 inches to 12 inches gouge
abusted parallel to the vein, contains considerable pyrite, sphalerite, chalcopyrite, galena, tetrabedrite, and some supergene covellite that has replaced chalcopyrite. A little free gold can be seen in some specimens. The sulphides are oxidized at the surface and for a few feet below. According to F. G. Innes, manager 1, the gold content of the quartz is extremely variable. He states that some samples assayed over 1.0 ounce of gold and 74 ounces of silver to the ton, but others assayed only 0.01 ounce of gold and less than 1 ounce of silver.

The tunnel on the Glasgow claim is run principally through altered and silicified granodiorite, which in places is cut by quartz veins and lamprophyre dikes (fig. 9). According to Mr. Innes, a sample of a quartz vein from 6 to 8 inches wide, which is exposed 150 feet from the portal to the tunnel, assayed 0.8 ounce of gold to the ton.

Fleck containing considerable scheelite occurs on the Apex Fraction claim and probably elsewhere. The scheelite is in what appears to be contact-altered limestone, containing abundant diopside, quartz, and calcite. Mr. Innes states that 10 samples of this material assayed from 4 to 30 per cent of tungsten trioxide.

Wilson group:—The Wilson property is near Profile Gap. Part of the claims are on the slope to Big Creek, and part on the slope to Profile Creek, adjoining the claims of the Profile-Yellow Pine Company on the north. Sam Wilson located the claims about 40 years ago and held them until the time of his death, in 1934. So far as known, he shipped no ore from these claims.

There are several short tunnels and surface cuts on the hillside that slopes to Big Creek, but most of the underground work has been done on the claims just north of the Profile-Yellow Pine group, where, in addition to a 30-foot shaft, there are two tunnels, one 570 and another 200 feet long. The shorter tunnel, which is 1,100 feet S. 20° E. from the Wilson cabin, is run principally in greatly silicified rocks that probably belong to the Challis volcanics. These rocks are largely replaced by quartz, but contain disseminated pyrite. A body of massive quartz is cut near the portal of the tunnel. The massive quartz and the highly altered Challis volcanics are separated by a dike of quartz latite porphyry about 40 feet wide. The contact between the dike and the quartz is marked by 1 to 4 inches of gray gouge. A lamprophyre dike cuts the silicified rocks near the face of the tunnel. The longer tunnel is run almost entirely in granodiorite of the Idaho batholith (fig. 10). In places the granodiorite is cut by lamprophyre dikes and quartz stringers. A drift about 450 feet from the portal of the tunnel follows a small quartz vein for about 30 feet. The quartz is from 1 to 6 inches wide and is said to be of good grade. The granodiorite throughout most of the length of the tunnel is considerably bleached and silicified and contains disseminated pyrite, whereas the lamprophyre dikes that cut it are relatively fresh and except for the ore followed for a short distance by the tunnel do not contain noticeable pyrite. The shaft near the northwest corner of the Glasgow claim of the Profile-Yellow Pine Company follows a small quartz vein in granodiorite. The quartz contains abundant sphalerite, galena, and pyrite, and is probably of good grade. The ore minerals, which fill fractures in the quartz, are intimately associated with sericite.

Large silicified and mineralized zones cut granodiorite on the Dundee and Dundee No. 1 claims of the Wilson group on the Big Creek slope of Profile Gap. These zones contain abundant stibnite and lesser amounts of sphalerite, galena, tetrabedrite, and pyrite. The more easterly mineralized zone is about 35 feet wide. Bands of stibnite in it strike N. 40° - 60° W. and dip 65° E. In another

1/ Personal communication.
Figure 10. Sam Wilson tunnel, Profile Gap.
zone of similar type about 250 feet to the west, bands containing stibnite strike about N. 60° W. and dip 85° E. Other mineralized zones are reported farther west. The sulphides in the mineralized zones crop out at the surface, although in places they are slightly oxidized. Some of the stibnite is coated with yellowish and reddish-brown oxidation products that are probably stibiconite and kermesite.

Several samples have been cut from the more intensely mineralized zones, and it is reported that some of these samples have assayed as much as 1½ ounces of gold to the ton. Bert P. Fisher reports that 15 tons of sorted ore from one of the mineralized zones shipped by him in 1935 yielded $75 a ton not at the smelter. Two samples cut by G. D. Meigh from the upper mineralized zone and from the face of a short tunnel just below the Edwardsburg road, 1,300 feet S. 70° E. from the northwest corner of Sec. 19, T. 20 N., R. 9 E., were assayed by E. T. Erickson in the chemical laboratory of the United States Geological Survey. The sample from the upper mineralized zone contained 0.01 ounce of gold and 1.22 ounces of silver to the ton and 0.85 per cent of antimony, and the sample from the tunnel contained 0.01 ounce of gold and 0.95 ounce of silver to the ton and 0.09 per cent of antimony.

Trigold:— The Trigold property is across Big Creek and about 1½ miles northwest of Profile Gap and is reached by a trail that gains over 1,200 feet in altitude between the crossing at Big Creek and the mine workings. The hillside up which the trail passes has a slope of 30° to 40°. The property was located in the seventies, but, so far as known, little or no ore has been shipped from it. In 1933 it was being prospected by the Lori Syndicate of San Francisco.

The rock of the hillside slope on which the Trigold is located has been glaciated and is therefore well exposed in most places. It includes granodiorite of the Idaho batholith and many Tertiary dikes. The most abundant dikes are dark colored lamprophyres and lighter colored quartz latite porphyry. The quartz latite porphyry dikes trend a little east of north; the lamprophyres trend both north and northwest. The granodiorite contains many small discontinuous quartz veins or stringers that trend north and a lesser number that trend northwest. One of the larger veins is partly exposed in a short tunnel from which a winze has been sunk. This vein strikes N. 13° W. and dips 65° E. The quartz in the vein, as exposed in the winze, forms a series of lenses rather than a single tabular body. The hanging wall of the vein is marked by about 1 inch of gouge. At the time of Shannon's visit, a long 15 to 18 inches wide was exposed on the side of the winze, and the top of another lane was exposed in the bottom. The quartz contains a considerable proportion of sulphides—named in order of abundance, sphalerite, galena, pyrite, chalcopyrite, tetrahedrite, and pyrrygzrite. The vein has been sampled by several mining engineers, among them Henry Abstein, who has compiled an assay map that shows the veins to contain from a trace to 6.10 ounces in gold and from 0.2 to 78.5 ounces in silver to the ton. The ore exposed in the winze is said to assay from 2 to 2½ ounces to the ton. According to Mr. Abstein, the best assays were obtained near points where lamprophyre dikes cut the veins.

Moscow (Moore) mine:— The Moscow group of claims, including those of Tony Ludwig, embraces 16 or more claims on the east slope of Moores Creek, 5 miles southwest of Edwardsburg and near the center of Sec. 6, T. 20 N., R. 9 E. The first claims were located in 1902 by S1 Boyles, who sold them to E. Moore in 1903. Moore constructed a 1-stamp mill in 1903 and for several years ran ore through it which he mined from a glory hole. Later Seely & Mudd and associates purchased the property, but in 1934 it was under option to the Lori Syndicate of San Francisco. The production of the property, about $9,000, came almost entirely from

1/ Personal communication.
The principal working at the Moscow mine is the Moore tunnel, a crosscut tunnel about 220 feet long, from which about 250 feet of drifts have been driven. A raise from this level extends up a glory hole. In 1934, a crosscut was started about 125 feet below the Moore tunnel and by September had been driven 80 feet (fig. 11).

The Moscow mine is in coarse-grained granodiorite of the Idaho batholith, which, in the vicinity of the mine, is cut by several Tertiary dikes, quartzite, limestone, and rotated rocks of the Yellowjacket formation crop out a few hundred feet east of the mine. The granodiorite in the Moore tunnel is greatly silicified and contains considerable disseminated pyrite and a little sphalerite, galena, tetrahedrite, chalcopyrite, and arsenopyrite. Stibnite was seen in float several hundred feet northeast of the Moore tunnel. In places the silicified granodiorite is cut by fractures containing dense bluish-gray quartz from an inch to 12 inches or more in width, which contain considerable disseminated arsenopyrite. Quartz of this type generally has the highest gold content. Several faults cut the granodiorite, and some of them have probably caused considerable displacement.

Several reputable mining engineers have sampled the Moore tunnel, but the results of their sampling differ greatly. For example, assays of samples cut from essentially the same place by two engineers differ by as much as $6.00 a ton. One reported an assay value of $1.86, whereas the other reported $6.91, with gold at $30 an ounce. According to the assay map of the mine workings, the average of several hundred samples cut throughout the mine at four different times is about 0.15 ounce to the ton. Henry Abstein, manager of the Iori Syndicate, states that about 40 feet of the crosscut will average 0.3 ounce to the ton, and that the selected ore milled by Moore ran about 0.30 ounce to the ton, although he saved only about 0.20 ounce.

Golden Way Up:— The Golden Way Up claims are on the ridge between Fall Creek and the North Fork of Logan Creek. Most of the workings are on the North Fork slope. The property is about 6 miles by road and trail west of Edwardsburg. The trail, which gains an altitude of 1,500 feet in about 2 miles, joins the Edwardsburg road at the mouth of the North Fork, near Tony Ludwig's cabin.

The Golden Way Up was first located by Charles Crow in 1899. John Compton, C. S. McKenzie, and others, did considerable development work after 1908, but the property was later abandoned. It was relocated by George Laufer and Joe Davis in 1908 and is now owned by Davis. The development work consists of several tunnels, probably 1,000 feet or more in total length. They range from 30 to over 300 feet in length and are nearly all accessible.

The tunnels have been run principally to develop a silicified lode which is perhaps 200 feet wide. The lode is similar to the mineralized zone that extends from the area south of the Moscow mine northward to the Independence, and probably it is a part of that zone. The lode is well exposed in the Ladder tunnel, which cuts across a zone of nearly pure quartz containing some sulphide in small veins and disseminated. Near the portal and in some other places the quartz also contains fluorite. The beds in the silicified area appear to trend N. 19° E. and dip about 80° SE. Textures resembling those of granodiorite can be recognized in the silicified zone near the Portal. Both granodiorite and schist crop out along the trail just east of the mineralized zone. An altered and silicified dike of quartz latite porphyry cuts the granite near the portal of the Ladder tunnel. No sulphides were noted in it.

²/Abstein, Henry, personal communication.
Figure 11. Moore tunnel of Moscow mine.
Pyrite is the most abundant sulphide in the silicified area, although tetra-
bedrite, sphalerite, and galena are disseminated through the rock. These sulphides
are partly oxidized at the surface, but are relatively free from alteration a few
feet below the surface. Some samples have been cut from the silicified zone, but
so far as known the property has not been adequately sampled. According to Henry
Abstein[{1}], the first 25 feet in the Ladder tunnel average 0.04 ounce of gold and
2½ ounces of silver to the ton, and samples cut from other places in the tunnel
rang 0.025 ounce of gold and 1.8 ounces of silver to the ton.

In addition to the large silicified lode a vein deposit, known as the Little
vein, has been opened by a tunnel 125 feet long. This vein strikes N. 40° - 50° E.
and dips 35° - 80° SE. In places it branches and is widest where the branches join.
The width ranges from less than 1 foot to 8 or 9 feet, but probably averages 2 feet.
The vein is composed of quartz that contains considerable sphalerite, galena,
pyrite, tetraehedrite, chalcopyrite, supergene covellite, and oxidation products.
The oxidation products are abundant near the portal of the tunnel and include
limonite, azurite, malachite, and manganese oxides. In places there are bands of
nearly solid sulphides in the quartz. Sphalerite and galena are by far the most
abundant of these sulphides.

Dixie:- The Dixie group (formerly the Goldman & McCrane property) adjoins the
Golden Way Up on the north. The claims extend across the divide between Logan and
Government creeks. They are owned by the Copper Camp Mining Company, Inc.

Several tunnels, most of them on the Logan Creek slope, have been driven on
the Dixie property. One starts near the level of Logan Creek and runs N. 20° E.
for about 100 feet. Another, the McCrane tunnel, runs about N. 60° W. for about
140 feet, and from it two drifts extend north and south. Several shorter tunnels,
not all accessible, lie west of the McCrane tunnel. Only a few tons of high-grade
ore have been shipped from this property.

The deposit at the Dixie is a bleached and silicified zone in granodiorite,
probably 200 or 300 feet wide, which, in places, is greatly sheared. This mineral-
ized zone was traced northward on the surface to the Independnce. Nearly every-
where within the mineralized body the granodiorite contains disseminated pyrite,
and in places the seams of quartz and pyrite are plentiful. The lode appears to
be more silicified in some places than in others, and these more strongly silico-
ified portions tend to weather out as more prominent outcrops. Some veins of
massive white quartz cut the mineralized zone. For example, a quartz vein about
3 feet wide is exposed in the west crosscut of the McCrane tunnel. A black lampro-
phyre dike follows the vein, but no quartz was observed in the dike, and it is
not excessively altered next to the quartz. Float from quartz latite porphyry is
abundant on the surface.

As a whole, the mineralized zone appears to be of low-grade, although some
high-grade ore has been found in it. According to W. A. Edwards, the manager, a
small streak of high-grade ore cut by one of the tunnels produced 2 tons of silver
ore that gave smelter returns of over $800 a ton. Unpleby and Livingston [{2}]
state that the McCrane tunnel is said to have averaged $2.15 a ton in gold, when gold was
$20 an ounce, and the lower tunnel about $8 a ton, although they remark that this
figure is open to question.

Independence:- The Independence property comprises ten patented claims on
upper Smith Creek a short distance east of Elk Summit. The road from Edwardsburg
to Warren crosses the property. The developments consist of three tunnels and

[{1}]Personal communication.

27.
several cuts. The upper or McCrae tunnel, which starts at the roadside, is 220 feet long, and the lower or Goldman tunnel is 320 feet long (fig. 12). A short tunnel about 40 feet long lies 40 feet northeast and 44 feet above the Goldman tunnel. The Goldman tunnel is 60 feet below the McCrae tunnel.

Dan McCrae located the Independence in 1898 and sold it to the Kansas and Texas Oil & Mining Company in 1901. The property is now owned by the Independence Mines & Power Company with offices in Topeka, Kansas.

The Independence lode is a wide silicified zone in rocks of the Yellowjacket formation near its western contact with the Idaho batholith. The Yellowjacket formation in the vicinity of the mine consists mainly of dark schistose argillites and quartzites, but includes also a band of crystalline limestone at least 100 feet thick. These rocks are cut by Tertiary dikes.

In the lode, the argillites and quartzites have been almost entirely changed by replacement to a nearly white rock composed largely of quartz, but containing also fluorite, sericite, calcite, and sulphides. A dike of quartz latite porphyry exposed in all three tunnels is considerably altered and contains some disseminated sulphides, but it has not undergone the intense replacement of the Yellowjacket formation. The rocks of the Yellowjacket formation show banding or flat attitude that may be bedding, although the bedding seen nearby on the surface was relatively steep. The sulphides are scattered throughout the silicified rock, but tend to concentrate along the flat bands. Fractures containing sericite, fluorite, and sulphides, cut the quartz. The sulphides are closely associated with the sericitized areas. They include pyrite, sphalerite, tetrahedrite, and galena. Even at the surface they are only partly oxidized.

The lode matter as a whole is obviously of low grade, although certain veinlets and irregular areas containing abundant tetrahedrite probably carry considerable gold and silver. The property has been sampled several times by competent engineers, but results of their sampling apparently vary considerably. So far as known, all indicate that the silicified material as a whole is of rather low grade.

W horrendoff and Pueblo:—The W horrendoff property is on Smith Creek about 5 miles from its junction with Big Creek. A poor road 6/4 miles long connects the mine with the Warren road near Elk Summit. A road was constructed up Smith Creek from Big Creek in 1933, so that the mine can now be reached from Yellow Pine by way of Edwardsburg and the Big Creek ranger station.

According to the 34th Annual Report of the Inspector of Mines for Idaho, 1933, the W horrendoff group comprises 21 unpatented claims, which include part of the old Pueblo group. In 1933, the W horrendoff property was not operating, although a well-constructed camp was maintained as a convenience to facilitate road work and for handling supplies on the way to the Golden Hand mine, 2 miles northeast. Nothing appears to have been done at the Pueblo mine for years, and the tunnels seem are so caved that little was learned regarding it.

The W horrendoff property was first located by Prindle Smith, but was relocated during the Thunder Mountain boom by Mr. W horrendoff. Most of the work was done on the property by the Keystone Mines Company after 1927. In 1933, the property was under the management of the Golden Hand, Inc.

Over 3,400 feet of underground work has been done and a 5-stamp mill constructed. All the workings are shown in figure 13, although the lower level was
Figure 12. Underground workings of Independence mine.
not accessible in 1933, and its position with reference to the other levels was taken from a map made by Gordon C. Smith.

The Werdenhoff mine is near the contact of the Yellowjacket formation and granodiorite of the Idaho batholith; the Pueblo group is in granodiorite. The Yellowjacket at the Werdenhoff mine is made up largely of light-colored quartzite, but also includes dark green argillite. In general, near the mine these rocks strike north and dip 30° - 40° W. They contain considerable granitic material, and the granodiorite in turn contains numerous inclusions of quartzite and argillite, so that the field classification at many places is an arbitrary one.

The granodiorite in the vicinity of the mine is coarse-grained and light-colored, and contains considerable muscovite, much of which is considerably shredded. Near the veins the rock is noticeably shattered, the feldspars are almost entirely altered to sericite, and considerable quartz has been introduced.

Quartz latite porphyry and dark-colored lamprophyre dikes cut granodiorite and the Yellowjacket formation in the vicinity of the Werdenhoff mine. The quartz latite porphyry, known locally as "birdseye porphyry", is exposed in several of the underground workings. Where fresh it has a distinct porphyritic texture. Large white phenocrysts of feldspar, some over 1 centimeter long, occur in a very dense bluish-gray groundmass, which also contains smaller phenocrysts of biotite. In most underground exposures in the Werdenhoff mine the quartz latite porphyry is considerably altered, particularly where the rock contained abundant pyrite. Oxidation products of the pyrite, along with iron oxides formed by the alteration of biotite and hornblende, stain the rock a brown color. Dikes of fine-grained, dark-colored lamprophyre are exposed in several of the workings and on the surface. Where least altered they are dark gray, but in most exposures underground the dikes are highly altered to soft brown rocks. One of the lamprophyre dikes cuts a quartz vein in tunnel 4.

Two quartz veins and a large body of irregular outline consisting mostly of quartz have been partly explored by the underground workings of the Werdenhoff mine. The quartz vein exposed in tunnel 4 is nearly vertical and strikes approximately east; the one exposed in tunnel 2 strikes about N. 35° E. and dips 60° - 90° E. The structure in the large silicified body known as the Keystone outcrop is uncertain, although its trend appears to be more or less nearly east. Quartz-filled fractures in this body, however, trend N. 45° E. and N. 15° E. The body of nearly solid quartz cut by tunnel 2 near the turn about 300 feet from the portal is probably the downward continuation of the Keystone outcrop.

The quartz vein on level 2 has been followed for 350 feet. At about 100 feet from the portal the vein branches into two parts. The east branch is followed for about 200 feet to a point where the vein appears to enter the east wall. The west branch is exposed by three short crosscuts and a short drift for a total distance of about 100 feet. The quartz along tunnel 2 ranges in width from about 3 feet to thin stringers, but probably averages 12 or 15 inches. It is considerably shattered and in most places is bounded by soft gray gouge. The quartz contains some disseminated sulphides, but they are largely oxidized. Tunnel 3, about 150 feet below tunnel 2, follows soft gray fault gouge from a few inches to over 2 feet thick. The gouge, which strikes about N. 30° E. and dips 30° E., contains fragments of quartz and quartzite. Massive white quartz with sparse sulphides is exposed in the crosscut about 170 feet west of the fault.

Tunnel 4, which is about 800 feet northwest of tunnel 2, is driven along a quartz vein for about 190 feet. The quartz is over 5 feet thick near the portal. About 6 inches, near the center of the vein, contains empty casts from which sulphides have been leached.
Although much of the ore at the Werdenhoff mine is oxidized, some sulphides are visible in all the veins. They include pyrite,chalcopyrite, sphalerite, galena, and tetrahedrite. The company's assays range from a trace up to 45 ounces in gold to the ton, and, as indicated by the assays, considerable portions of some of the veins may average as much as 1/2 ounce to the ton.

The dumps at the Pueblo mine indicate that the character of the mineralization there is broadly similar to that at the Werdenhoff, although the country rock is granodiorite instead of being mostly quartzite and argillite.

Golden Hand, Inc.:-- The group owned by the Golden Hand, Inc., including the Old Neversewet, contains 26 unpatented claims. The property is near the head of Cache Creek, 6 miles by road northeast of the Werdenhoff. The road is very steep in places and crosses a divide at an altitude of about 8,300 feet. A good camp has been constructed at the mine, and in 1933 a small Straub mill with a daily capacity of 6 tons was being operated.

Most of the underground work south of Cache Creek was done by the Penn-Idaho Company on the Neversewet claim shortly after the Thunder Mountain boom. In 1933 the Golden Hand, Inc., had driven two tunnels, 70 and 150 feet long, and was mining from an open cut near the portal to the shorter tunnel (fig. 14). Production figures are not available for the recent output, but it is known that considerable high-grade oxidized ore was milled in 1933-34. Several years ago the Hand brothers took out about $1,200 from two short tunnels on the north side of Cache Creek.

The Golden Hand property is near the contact of the Yellowjacket formation and granodiorite of the Idaho batholith. The Yellowjacket formation contains many irregular bodies of granodiorite, and both granodiorite and Yellowjacket formation are cut by numerous light and dark colored Tertiary dikes. The Yellowjacket formation near the mine consists chiefly of dark-colored schist, schistose argillite, and quartzite. These rocks form a prominent hill above and west of the open cut. Near the cut the beds strike N. 10° W. and dip 30° SW., but on the west side of the hill they strike N. 10° W. and dip 30° NE. Hence, the hill marks a synclinal fold. The ore thus far developed lay chiefly along joints and shear planes in granodiorite and schistose rocks of the Yellowjacket formation, although a little disseminated pyrite and tetrahedrite occur in a quartz latite porphyry dike in the lower Neversewet tunnel. The ore minerals include pyrite, galena, sphalerite, tetrahedrite, chalcopyrite, and gold. In the ore the granodiorite and schist have been greatly fractured, and quartz, calcite, sericite, and epidote fill the fractures and form irregular bodies near them. Sulphides and gold occur in fractures in quartz and calcite and along cleavage planes in calcite. In some of the ore from the open cut gold visible to the eye was very abundant in massive tetrahedrite. A. F. Richards, superintendent, stated that the ore from the open cut was plating $50 a ton. Sulphides occur at the surface, although in places there is considerable oxidation, particularly in the open cut.

In 1933, the development work was not sufficient to determine the extent of the ore body exposed in the open cut, although at that time it was planned to drive the lower tunnel ahead and thus prospect the ground about 100 feet beneath the cut. In driving the lower tunnel a band of well-mineralized schist that appears to be of good grade was cut about 70 feet from the portal. It is an inclusion in the granodiorite and hence is probably of irregular outline and small dimensions. Numerous small stringers containing tetrahedrite were also cut near the face of the tunnel, and although these stringers are probably of high-grade in themselves, they do not appear to be numerous enough to make the granodiorite mineable under present conditions.
Figure 14. Workings of the Golden Hand mine.
Ramey Ridge, on the north side of Big Creek between Ramey and Beaver creeks, is one of the widely mineralized areas in the region. It contains many prospects, but, although most of the deposits have long been known, there has been little development and almost no production, in part because of difficulty of transportation. Until 1934 the deposits were nearly a day's trip by pack train beyond the end of the road. Copper Camp, at the south end of Ramey Ridge, is described separately as it differs from the others in being held for copper rather than precious metals. The Arrastre (Mildred) group of five claims at the head of the east fork of Milligan Creek, formerly owned by the late Walter Estep, is the best developed property on Ramey Ridge. The Mohawk, Apex, Betty Jane, and other properties, are scattered over the ridge (fig. 2). They are developed by cuts and tunnels, most of which are less than a few score feet long. The Mahan property, on Milligan Creek, has an old 5-stamp mill in disrepair, a new handmade, 1-stamp mill, and a few scattered short tunnels. The old mill is reported to have been operated for a short time on float ore picked up from the hillside below the Apex workings.

Most of the mineral deposits on Ramey Ridge are in dark-colored quartz-diorite, containing abundant magnetite. This rock is cut by scattered Tertiary dikes and in places contains fragments of both dark and light colored quartzite. An irregular mass of gneissic diorite near the southeast end of the ridge extends northward into the Arrastre group and forms the principal country rock of that property. The deposits are lenticular bodies of vein quartz that strike east, within limits of 10° to 20° either way, and dip north at various angles. Some of the veins lie nearly flat, whereas others have dips of 70° and more. The diorite near the veins is sheared and chloritized, and some fissures are lined with gouge. The individual quartz lenses exposed in some of the prospects are from a few feet to a few score feet long and rarely over 3 feet wide, and the marked local variation in attitude of both the lenses and the associated shearing leads to the conception that most of the lodes are not persistent. However, one of the Arrastre group oro veins has been demonstrated to be essentially continuous for about 1,200 feet with a width of 5 to 10 feet, and it is entirely possible that adequate development would prove the existence of comparably persistent veins elsewhere on the ridge. Minor landslides have occurred in several places on Ramey Ridge, and these should be avoided in prospecting, because the fragments of ore that may be found in them obviously will not lead into masses of commercial size. If ore is noted in landslide rubble, its bedrock source should be sought on the hillside above. One of the tunnels on Ramey Ridge is in loose material evidently of landslide origin.

The metal of the lodes occurs mainly in the vein quartz, but is present also in the adjoining altered diorite. Some high-grade ore has been found, but much of the ore is of moderate to low grade. Most of the ore exposed in the various properties is oxidized, but much of it contains sparsely distributed grains of residual pyrite and chalcopyrite. The quartz is honeycombed with limonite-lined cavities and is coated and stained with pulverulent yellow to brown limonite. The unaltered quartz is glistening and semi-translucent, and in places shows comb structure. Oxidized siderite was noted on the dumps of the caved Apex tunnels, but not elsewhere. Copper stains are common in the ore at several of the prospects.

**Arrastre (Mildred):** The Arrastre property is on Milligan Creek, a tributary of Beaver Creek. In 1933, it was about 12 miles by trail from the nearest road at Big Creek headquarters, but in 1934 a road was under construction down Big Creek, which, when completed to the mouth of Beaver Creek, will shorten trail travel to about 3 miles. T. G. Thomas discovered the deposit in 1906, and it was known as the Mildred until after his death, when Walter Estep relocated it.
The prevailing country rocks in the vicinity of the mine are coarse-grained gneissic diorite and dark-colored argillite, some of which is decidedly schistose. Several quartz veins cut both diorite and argillite, but they occur principally in the diorite. One of the veins has been partly exposed on the surface for 1,000 or 1,200 feet by numerous cuts. At the place where the most work has been done, two short tunnels expose the vein underground (fig. 15). The lower one intersects the vein about 65 feet below the outcrop. There are other minor workings on the property, only in part shown on figure 15. The vein ranges from over 10 feet to less than 2 feet in thickness where exposed by openings on the surface, but it probably does not average more than 4 or 5 feet. The veins strike nearly due east and dip at steep angles to the north. In places the quartz is considerably shatterely and contains some pyrite and chalcopyrite, although for the most part the veins, where exposed, are oxidized and stained yellow or brown with iron oxides and less commonly green with copper carbonates. Several samples have been taken from the veins, mostly from the cuts and tunnels. They indicate that the gold content ranges from less than 0.1 ounce to over 2 ounces to the ton. Mr. Estep stated that samples cut by engineers show an average gold content of 0.45 ounce for the quartz exposed in the cuts and tunnels along the principal vein. A sample cut by C. P. Ross across the quartz exposed in the lower tunnel was assayed in the chemical laboratory of the United States Geological Survey and found to have a gold content of 1.66 ounces to the ton. There is no record of production except that T. G. Thomas is reported to have recovered $37 in gold (at $20 an ounce) from a lot of 1,800 pounds of ore run through an arrastre as a test.

**Jensen group:** The Jensen group of claims is on the north side of Crooked Creek about 5 miles above its confluence with Big Creek. It was located and has been developed up to the present time by two Jensen brothers, who came here during the Thunder Mountain boom. In the summer of 1929, equipment and supplies were brought to the property by pack train preparatory to an active campaign of development; in 1930, the mine was idled, but in 1933 and 1934 considerable development work was undertaken.

When the property was visited in July, 1929, the new work had not yet started. There was a small, ingeniously constructed mill close to Crooked Creek and several short tunnels at intervals for several hundred feet vertically up the slope to the north. The principal working, high on this slope, was connected with a loading station in the gulch above the mill by a gravity tram. This working consisted of a tunnel on the vein a few hundred feet long, with a winze near the face connected with a short drift about 75 feet below.

The wall rock of the deposit is somewhat gneissic biotite-quartz diorite, which, in this general vicinity, contains many highly altered inclusions of sedimentary rocks, mainly schist, white quartzite, and, near the Jensen cabin, limestone. There are also many Tertiary dikes, mainly granophyre. The ore is an irregular sheared zone 1 to 5 feet wide in the diorite with numerous curves and broken by several minor cross faults. The average strike is N. 50° W., and the average dip 60° NE. Most of the cross faults have displacements of only a few inches, and the maximum offset exposed in the mine is 6 feet. In several places the shearing splits and passes around horizons of gneissic diorite darker and finer-grained than the average. In one place there is a mass of schist a few feet long which dips northeast, opposite to the average shearing.

The shear zone contains at intervals lenses of banded, coarse-grained, glistening, semi-translucent quartz with chalcopyrite, pyrite, and pyrrhotite irregularly scattered through it. There has been some supergene copper enrichment. Most of the ore is reported to carry $20 to $50 to the ton in gold and silver, but ore of much higher-grade has been found in small lenses and kidneys.
Figure 15. Principal workings of the Arrastre property.
at intervals along the hanging wall. Some of the specimens of the high-grade ore contain much native gold. Bell reports that average assays of this high-grade ore run 25 to 40 ounces of gold to the ton, with 15 to 20 ounces of silver, and some of the picked rock doubtless runs even higher than this. The Jensen brothers have largely supported themselves for over 20 years from the proceeds of the ore from their mine, but the small amount of stoping shows that the total tonnage mined has been small.

Deposits in and near Chamberlain Basin

James and M. J. Hand have prospects on the ridge south of Sheepeter Peak on the west rim of Chamberlain Basin. Cuts on the east flank of the ridge disclose two veins, of which the larger strikes N. 70° E., stands vertical, and has partings striking N. 8° W. parallel to the structure of the enclosing gneiss. The vein consists of 3 to 4 feet of quartz, frozen to the walls and containing tremolite and small amounts of pyrrhotite and galena. These claims, located in 1923, are held for lead and silver, but they also contain gold. On the crest of the ridge the ore is cut, pits, and trenches put down by the same prospectors in a search for the bedrock source of the gold stated to be widespread in the soil in this vicinity. Soil and loose weathered material covers the bedrock to depths of 5 feet and more.

On the northeast slope of Chamberlain Basin close to the West Fork of Chamberlain Creek there are several prospect cuts and pits. Most of these were not seen during the present study, but Al Stonebreaker, one of the owners, states that they show seven lodes containing copper-silver-gold ore trending a little west of north. He says that there is one 50-foot shaft on a vein 23 feet wide which assays $8 a ton at the top and $30 a ton at the bottom of the shaft (with gold at $20 an ounce). All the other veins are smaller and are developed by cuts. Specimens furnished by Mr. Stonebreaker show that the ore is largely oxidized, but contains hypogene (primary) pyrite and chalcopyrite, and small amounts of supergene (secondary) chalcosite.

Copper deposits

General features

The copper deposits are of two types; (1) well-defined veins containing quartz, magnetite, and pyrite associated with copper minerals, and (2) irregular-shaped deposits in limestone, quartzite, and argillite. The deposits at the Missouri and Iron Clad, which are included in the latter group, are associated with shear zones and consequently in part have a vein-like form.

The deposits in well-defined veins are best developed at Copper Camp. The veins here are very extensive and contain a high proportion of magnetite, but, from the information available, the copper content appears to be low. The irregular-shaped deposits in limestone, quartzite, and argillite, thus far developed are relatively small. In general, the copper minerals in them are sparsely distributed, but in places the ore is of relatively high-grade.

Copper Camp

The property, which for many years has been known as Copper Camp, was located in 1888. It is on the north side of Big Creek about 9 miles from the Big Creek ranger station. The Copper Camp property, which comprises 18 quartz and 2 placer claims, is held by the Copper Camp Mining Company.

Numerous cuts and short tunnels are scattered over the property. The longest and oldest of these in mineralized ground is on the Black Bear claim. It is 140 feet long, and two short crosscuts have been turned from it. A crosscut about 200 feet lower than this tunnel is reported to have been driven 545 feet from a point on Camp Creek, with the intention of intersecting the Black Bear ledge. 1/ This crosscut passed through blocky quartzite slate for the whole distance, but is said to be about 400 feet short of its destination.

The ore deposits at Copper Camp are in dark-colored quartzite and argillite of the Yellowjacket formation close to its contact with the overlying Hoodoo formation. The quartzite and argillite vary considerably in strike and dip, but in the vicinity of the veins the prevailing strike is east of north and the prevailing dip to the east. In several places dips of 60° E. were recorded, but dips near the Black Bear tunnel are considerably flatter. Many Tertiary dikes cut the Yellowjacket beds near Copper Camp. Dark-colored lamprophyres were seen on the surface and in some of the underground workings. Quartz latite porphyry forms the hanging wall of a vein on the west side of Spring Creek, and similar rock was seen on dumps of caved tunnels and as float in several places on the surface. The topography in the vicinity of the Copper Camp property shows irregularities which indicate that small landslips have taken place. They are all sufficiently ancient to be clothed by vegetation, but they should be considered when planning development work or tracing lodes on the surface.

Several veins cut the rocks of the Yellowjacket formation on the Copper Camp property. Umpleby and Livingston 2/ state that the Black Bear vein can be traced for at least 2,500 feet along its strike and that five other narrower veins on the property are parallel to each other, but converge somewhat eastward. The Black Bear vein is the best developed. It strikes east across nearly flat-lying beds of the Yellowjacket formation, but does not have a constant dip. Near the face of the Black Bear tunnel the dip changes from about 20° N. to 75° N., but near the portal it is about 40° N. The vein lies along a shear zone and ranges from 6 feet to over 10 feet in thickness. The shear zone contains partly oxidized chalcopyrite, magnetite, pyrite, andchalocite disseminated through crushed quartzite. Another vein, a few hundred feet up Camp Creek, of almost solid quartz about 30 inches wide, strikes N. 55° E. and dips 65° N. It is considerably fractured and contains abundant iron and copper oxides. Several short tunnels and cuts also expose veins west of the Black Bear. These veins are 5 or 6 feet or more wide and consist of quartz with very abundant magnetite, almost solid in places, and subordinate chalcopyrite and pyrite. Reliable strike readings could not be made with a compass, because of the magnetite, but, in general, these veins trend northeast and dip 50° – 60° NW. The argillite nearby strikes about N. 60° E. and dips 60° 32'. These veins continue westward across Spring and Copper creeks for some distance.

The principal mineral, magnetite, is massive and does not show the common alteration to hematite. Chalcopyrite and pyrite occur in samples taken from the veins, but they are not abundant. Chalcopyrite appears to have formed later than the magnetite, as it tends to occur along fractures. At the surface the magnetite is usually somewhat altered to brown "limonite," and malachite has formed from chalcopyrite, staining much of the vein material a green color. Samples of vein material from an outcrop on the west side of Copper Creek and from an outcrop between Spring and Camp creeks were tested by Charles Hilton in the

chemical laboratory of the United States Geological Survey. He reports as follows: "The samples are magnetic with some malachite, and they therefore contain ferrous and ferric iron and copper. No reactions were obtained for tin, zinc, nickel, chromium, manganese, or titanium. The absence of manganese makes it unlikely that columbium, tungsten, or tantalum are present in any significant quantities. No radioactivity was observed".

So far as known, the veins have not been adequately sampled. However, much of the vein material is made up largely of magnetite, and from inspection it obviously does not contain much copper. In other places, considerable copper can be seen. W. A. Edwards, the manager, who kindly guided the writers during their visits to the property, stated that he had got assays that ran as high as 13 per cent in copper, but, in general, the assays indicated from 1 to 4 per cent. He stated also that the gold content in the black Bear tunnel might average $3 an ton, but that samples from a cut west of the Black Bear had assayed $40 a ton.

Profile-Tamrock

The Profile-Tamrock Mines Company controls three groups of claims containing copper ores. These are (1) the Copper Cliff group, near the head of Missouri Creek, a short distance south of Pinnacle Peak; (2) the Missouri Creek group, on the southeast slope of the valley of Missouri Creek about a mile southwest of the Copper Cliff; and (3) the Ryan Creek group, embracing an area between Ryan and Spring creeks, two small tributaries of Profile Creek a short distance southeast of Profile Gap.

The Copper Cliff group is developed only by shallow cuts. The Missouri Creek property has one tunnel several hundred feet long and several shorter tunnels and cuts, but most of its workings were not safely accessible in 1929. The Ryan Creek group has several cuts and short tunnels, but development on it started a few years ago and has been carried on only by one or two men during the summer. The other two groups have been inactive for some time.

The Copper Cliff and Missouri Creek deposits are essentially similar. They are in dark, impure Paleozoic limestone cut by dikes of granodiorite and aplite rock (Mesozoic) and granophytic porphyry (Tertiary). The limestone of the deposits is broken by various small slits and contains such metamorphic minerals as scapolite, pyroxene, and epidote. Chalcopyrite and pyrite have been formed by replacement in the limestone and also coat some of the fissures. The scanty exposures give no indication of any regularity in the shape or trend of the deposits. The dumps at the Missouri Creek tunnels contain small amounts of chalcopyrite ore that probably contains several per cent of copper.

The Ryan Creek group is in much-broken limestone and quartzite engulfed in light-colored granitic rock, with aplite dikes and stringers bleached by hydrothermal alteration. In both of the sedimentary rocks, but mainly in the limestone, there are more or less irregular seams of pyrite, sphalerite, galena, and chalcopyrite in varying amounts in quartz and fine-grained altered rock. Some seams follow the bedding. Some of the ore is so complete a replacement of igneous stringers by the metallic minerals, with quartz, calcite, and epidote, that the original character of the rock can be discerned only with difficulty. There are several bodies of high-grade sphalerite-galena ore, but those seen appear to have maximum dimensions of only a few feet and are surrounded by slightly mineralized limestone. Additional development may uncover larger bodies. On Ryan Creek there is reported to be a large exposure of rather sparsely disseminated galena in quartzite.
The Iron Clad group covers a wide area on the west side of Monumental Creek near and north of Copper Creek. It is under the management of Jesse R. Butler and includes two distinct groups of workings. One, called the Iron Clad, is near the head of Copper Creek. It was not visited, but is reported to show a very large outcrop of ore containing gold and some copper. Test runs of this ore have been made in a small stamp mill on Monumental Creek, connected with the prospect by a tramway. The material at the mill is a breccia of Yellowjacket quartzite and vein quartz, much stained with limonite and containing free gold. The other group, known as the Copper prospect (Fig. 2) lies about 2 miles north of Copper Creek. There are two short tunnels and some small cuts here. The country rock belongs to the Yellowjacket formation, which, close to one of the tunnels, strikes N. 5° E. and dips 70° SE., in approximate conformity with the average attitude in this vicinity. There are several roughly parallel quartz lomos, two of which are followed by tunnels. The most definite of these strikes N. 8° W. and dips 36° NE., parallel to the major shearing in the country rock, but near it there are somewhat mineralized shear planes with various attitudes. The vein quartz introduced along the shear planes was deposited mainly by replacement. In both tunnels the quartz contains rather sparsely disseminated, partly oxidized chalcopyrite and pyrite. Some of the adjoining quartzite is cut by closely spaced sheeting lined with green biotite bands about an eighth of an inch wide, with small amounts of chalcopyrite in the intervening quartzite.

Deposits in Tertiary rocks

General features

Deposits in Tertiary rocks occur over large areas in south-central Idaho, but all the developed properties in the region covered by this report are in the Thunder Mountain district (Fig. 16). The known deposits of ore are of considerable lateral extent, but vertical development in the mines indicates that the gold content decreases rather rapidly below certain horizons. The deposits in the Thunder Mountain district occur in rocks correlated with the Challis volcanics and are valuable for their gold and silver content, principally gold. In general, the ore is so inconspicuous that it can hardly be told from altered rock without testing. It contains only a very small proportion of sulphides. Pyrite is the most abundant, but a little pyrrhotite has been found at the Dewey mine, and chemical tests showed the presence of about 1 per cent of selenium in a concentrate from a small vein containing pyrrhotite.

Some enrichment of the gold by solution and redeposition has taken place. It is most conspicuous at the Sunny Side mine where much of the gold appears to have migrated downward from 1 to 10 feet below a mud flow against which the hypogene (primary) ore was deposited.

The average ore in general is of relatively low-grade, although high-grade stringers have been found. For the Thunder Mountain district the gold content has ranged from less than 0.20 ounce to more than 1½ ounces to the ton. The average gold content of the ore mined appears to be about 0.375 ounce to the ton.

Origin of the gold in the Tertiary deposits

The alteration of the rocks associated with the ores suggests that the gold was deposited by tenuous solutions which were thoroughly diffused through certain of the more permeable parts of the Challis volcanics. Where conditions were favorable concentration took place. The fault zone at the Dewey mine, which
Figure 16. Map of the Thunder Mountain district, Valley County, Idaho.
apparently provided a relatively easy path for solutions, and the impervious mud flow at the Sunnyside, which trapped upward-rising solutions, each in a different way appears to have brought about such concentration.

Oxidation, particularly at the Sunnyside mine, makes the interpretation of the alteration uncertain, but it seems likely that the intense silicification in many places throughout the mine and the association of certain clay minerals with the ore are results of alteration by hypogene solutions. Two slightly different clay minerals rich in potash, but containing almost no soda, are found in the altered rocks. According to C. S. Ross 1, in clays produced by weathering the reverse is generally true, even though many of the rocks weathered contain abundant potash. It is likewise believed that the gold at the Dewey mine was originally deposited by hypogene solutions, which also caused the intense silicification of the sandstone beds near the mine. It is likely that enrichment of the gold by supergene processes also took place at the Dewey. The workings of the mine were not accessible for study by the writers, but at the surface the sulfides are largely oxidized, and at least some of the gold was probably carried downward by surface waters.

The data summarized above imply that the dominant process of mineralization was diffusion of hypogene solutions and deposition from them, but the source of these solutions is not evident. The nearest known exposure of Miocene (?) granitic rocks is over 11 miles to the east 2. However, both light and dark colored dikes cut the Challis volcanics near Thunder Mountain, and it is presumed that they came from a deep-seated source that may have supplied mineralizing solutions. Furthermore, an area of greatly epidotized and otherwise altered rocks about 2 miles northeast of Thunder Mountain suggests that granitic rocks may not be far beneath the surface in that vicinity.

Dewey

The Dewey mine is in an amphitheater-like valley near the head of Mulo Creek (figs. 6, 16, and 17). The mine is reached by a trail that runs up Mulo Creek Canyon from the old town of Roosevelt on Monumental Creek. The first claim of the Dewey group was located by A. B. Caswell, L. J. Caswell, and A. O. Huntley in 1896. In the summer of 1901 the locators sold the property to Colonel W. H. Dewey for $100,000. During the same year a 10-stamp mill was brought in by pack horses, and underground development was started. In 1902, T. M. Barnsdall acquired an interest. The property was operated until November 1907. Since then the mining activity has largely been confined to placing old dumps and slide material from the hillside. The total production of the Dewey mine is approximately $385,000. About $20,000 was taken out by placer methods prior to 1901, and probably a similar amount after 1907. The following table was taken from the records of the United States Bureau of Mines and is published with the permission of R. A. Davis.

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1/ Personal communication.
Figure 17. Landslide area west of Thunder Mountain.
Production of the Dewey mine, Thunder Mountain district, Idaho

<table>
<thead>
<tr>
<th>Year</th>
<th>Crude ore (tons)</th>
<th>Gold (ounces)</th>
<th>Silver (ounces)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1902</td>
<td>3,162</td>
<td>711.63</td>
<td>394</td>
</tr>
<tr>
<td>1903</td>
<td>4,123</td>
<td>1,030.00</td>
<td></td>
</tr>
<tr>
<td>1904</td>
<td>8,656</td>
<td>3,926.00</td>
<td>2,239</td>
</tr>
<tr>
<td>1905</td>
<td>10,464</td>
<td>3,171.48</td>
<td>2,092</td>
</tr>
<tr>
<td>1906</td>
<td>11,786</td>
<td>3,089.95</td>
<td>2,126</td>
</tr>
<tr>
<td>1907</td>
<td>8,920</td>
<td>1,784.73</td>
<td>1,248</td>
</tr>
<tr>
<td>1911</td>
<td>732</td>
<td>207.86</td>
<td>122</td>
</tr>
<tr>
<td>1916 8/</td>
<td>109.52</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>1918 8/</td>
<td>211.19</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>1919 8/</td>
<td>93.45</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>47,823</td>
<td>14,341.81</td>
<td>8,494</td>
</tr>
</tbody>
</table>

8/ From placerng old dumps

The mining and milling costs were remarkably low for a region as isolated as Thunder Mountain during the time the mine operated and in view of the fact that square sets were required in all the stopes. In 1905, the mining cost was $2 a ton and the milling cost $1.28 a ton. During the first year the recovery in the mill was only 75 per cent, but thereafter it was 80 per cent or more. 1/

The company maps show that the property comprises 13 claims, including several fractions, which in all cover 141.26 acres. A 10-stamp mill, office, assay office, boarding house, and other buildings are on the property, but all are in disrepair. As shown in figure 18, there were more than 2,000 feet of underground workings on two main levels and several intermediate levels and short tunnels. They extend through a vertical range of about 240 feet. In addition, considerable surface excavations were made, mainly by sluicing, in the area over and immediately south of the main workings. There are also several short prospect tunnels, not shown in figure 18, scattered over the property. Practically all the underground workings are inaccessible.

The rocks in the immediate vicinity of the Dewey mine include a series of interbedded shales, sandstones, and tuffaceous beds, landslide material, and some small patches of basalt. Flow breccia and other bedrocks crop out on surrounding ridges. Dewey Hill, which is a prominent outcrop of the interbedded rocks, stands nearly 500 feet above its surroundings (fig. 17). It is about 2,500 feet long and is entirely encircled by landslide material. In the exposed section sandstones are most abundant, but there are many interbeds of shale and conglomerate and a few thin layers of impure lignite. The sandstones and associated rocks have an exposed thickness of over 400 feet. Wood and plant fragments are very abundant throughout the series. Large lags were found in the course of mining, and of these contained much free gold. 2/

Near the east side of Dewey Hill a basalt dike 20 feet wide cuts shale and sandstone beds and merges into a flow. Other basalt flows crop out nearby. The attitude of the sandstone and other beds near the Dewey mine varies somewhat because of irregularities in original deposition.

1/ Data from old account books.
and because of faulting and landslide disturbances, but, in general, they are nearly flat. The general dip of the beds probably averages 150° E.

Because the underground workings are almost entirely inaccessible, information given here on the occurrence of the ore is taken largely from reports by Umpleby and Livingston /1/ and Bell /2/, and from oral descriptions given by D. C. McCrae, C. W. Neff, Samuel Hancock, and J. J. Oberbillig, who were familiar with the mine when it was operating. This information is supplemented by what can now be seen on the surface.

The ore is an altered rhyolitic tuff, sandstone, and interbedded rhyolitic lava. Some descriptions refer to mineralized "black breccia," which may be similar to the peculiar black rock exposed in the old caved stopes at the surface. It is made up of angular fragments of sandstone, shale, carbonized wood, and mud cemented together by a coarse, rather even-grained sandstone. The best ore, including that mined and milled, was found in a steeply dipping zone of intensely altered and sheared rock with a strike ranging from nearly east at the west end of the mine to about N. 30° W. at the east end (fig. 18). This is probably the same fault zone that is exposed in the caved stope at the surface. The distribution of the underground workings indicates that it probably had the shape of an arc. The bedrocks on both sides of the fault zone and throughout most of Dewey Hill are intensely silicified, and because of this silicification the hill has acted as a buttress around which the landslides have passed. Considerable clay was developed along the fault zone, and hence the workings were maintained with difficulty. Nevertheless one stope was 10 sets high, several sets wide, and 46 sets long. In places this stope was mined all the way to the surface. Ore sufficiently rich to be sent to the mill was found from the surface down to a depth of 114 feet or more. Mineralization was shown to persist to a depth of about 250 feet, but the grade of the material on the lowest level was apparently so low that it discouraged further mining. Development on level 1 penetrated mineralized ground for a length of over 600 feet and a width of over 200 feet, but much of this material was evidently of low-grade.

Gold is associated with very sparsely distributed sulphides. Partly because of the sparse distribution only two sulphides were recognized, pyrite and pyrrhotite. Nodules of pyrite containing leaf gold in the center were found, and assays of the mineral indicated a gold content of 2 ounces to 4 ounces a ton, /3/ much in excess of the average tenor of the ore. Perfect crystals of pyrrhotite with well developed a (1120) and c (0112) faces were found in a concentrate collected from a small vein by Robert McCrae. This concentrate was tested in the chemical laboratory of the United States Geological Survey by E. T. Erickson and was found to contain about 1 per cent of selenium. A concentrate consisting largely of pyrite, from a sluice box on the west side of Dewey Hill, contained no selenium. The gold apparently tended to be concentrated in cracks in the rocks rather than to be distributed evenly through it. Hence the best information available on the grade of the ore mined is that of the production record, to which 20 per cent should be added to compute the run of mine ore, because only 80 per cent of the gold was saved in the mill. The highest annual average recovery during the period from 1902 to 1907 was 0.456 ounce of gold and 0.259 ounce of silver to the ton in 1904, and the lowest was 0.200 ounce of gold and 0.140 ounce of silver to the ton in 1907. The weighted mean for this period was 0.2815 ounce of gold and 0.1884 ounce of silver to the ton. It is reported that the ore mined

Figure 18. Underground map of the Dewey mine, Thunder Mountain district.
ranged in value from $6 to $30 (old price) a ton and that the average toner decreased with depth.

Sunnyside

The principal workings of the Sunnyside mine are about 2,500 feet north of Thunder Mountain, on a nearly flat divide between Mule Creek and a tributary to Marble Creek. The mine is reached by two trails from Monumental Creek, of which one goes up Mule Creek past the Dewey mine, and the other, the cut-off trail, leaves Monumental Creek near the Twentieth Century mill and goes past the H-Y and Standard mines. The trail up Mule Creek gains an altitude of 2,000 feet in about 3 miles.

The Sunnyside group includes claims that were originally located by several different parties, but the first location was made by the Caswell brothers in 1899. In 1901, they sold their property to the Lightning Peak Gold & Silver Mining & Milling Company, which in 1902 was reorganized into the Belle of Thunder Mountain Mining & Milling Company. This organization did considerable underground development, built a 25-stamp mill at Belleco, on Marble Creek, and constructed an 8,000-foot tramway from the mine to the mill. The property was later abandoned, but it was relocated in 1922 by D. C. and Robert McCreas and R. A. Davis. They constructed a 10-stamp mill near the mine and have operated the property in the summer since that time. Robert McCreas states that the mill at Belleco treated about 1,800 tons of ore and that the total output of the Sunnyside mine 1933 was about $50,000.

The developments on the three upper levels of the Sunnyside (fig. 10) include over 4,500 feet of drifts and crosscuts in addition to several stopes, almost all accessible except the Burr Oak tunnel, a long tunnel 180 feet below the intermediate level. The assumed altitude at the portal of the McCreas tunnel, the lower of the accessible tunnels, is 7,950 feet. The altitude of the portal of the upper or Sunnyside tunnel is 7,993 feet, and that of the top of the connecting raise to the intermediate level is 7,972 feet.

The ore at the Sunnyside mine occurs in flow breccia and related rocks. Near the mine these rocks are overlain by sandstone, shale, and angular conglomerate, and by a mud-flow of uncertain origin. The flow breccia where fresh is a black, glassy rock with many angular glass inclusions and small crystals of feldspar and quartz. Many of the quartz crystals are well formed and doubly terminated. In most places, the flow breccia has weathered to a purplish-gray rock with glassy-appearing quartz and feldspar crystals and altered glass inclusions. Streaking is preserved or accentuated by the weathering, and the quartz and feldspar crystals are made more conspicuous. In mineralized areas the glass inclusions are changed to clay minerals, which in many places at the surface are removed by weathering, the rock thus having a pitted appearance. The groundmass of this rock, which is well developed in the McCreas tunnel, is also considerably altered to clay minerals and is in general considerably silicified. Clay minerals are abundant in the better grade ore, which is either white or stained brown or black by iron and manganese oxides. Mixtures of two slightly different clay minerals resembling hydro-micas are present both in the altered rock and in fractures cutting it. Embedded in the clay are numerous small, doubly terminated quartz crystals.

The interbedded sandstones, shales, and conglomerates that overlie the flow breccia crop out over a small area on the divide about 300 feet west of the Sunnyside air raise. These beds contain numerous organic fragments, are intensely silicified, and otherwise resemble the formations at the Dewey mine. Similar

1/ Personal communication.
Figure 19. Map of the Sunnyside mine, Thunder Mountain district, with cross sections through the Sunnyside ore body.
though less silicified rocks are exposed on dumps on the divide southeast of the Venable mine.

The mud-flow of uncertain origin occupies an area about 3,000 feet long and 300 to 900 feet wide on the divide above the Sunnyside mine (fig. 16). The mud can be best observed in some of the underground workings, where a thickness of over 60 feet is exposed. It consists of dark gray, fine-grained, muddy material with numerous large and small rock fragments and much carbonized wood, which are distributed throughout the mud without any apparent sorting. The rock fragments range in size from tiny pebbles to boulders that weigh several tons. They are largely angular and where seen underground are made up mostly of sandstone, shale, and flow breccia. Whon wet, the mud is plastic like molasses. It resembles the material in the recent (1909) mud-flow in Mule Creek Canyon, except that it does not contain boulders of basalt. In some places, for example, in the two longest crosscuts to the west on the Sunnyside level, the mud has been greatly silicified.

The western slope of Thunder Mountain is free from vegetation and shows good rock exposures, but, although the slope was carefully inspected, the mud-flow (fault of Livingston) could not be found cutting through the hill. Therefore, if the mud is a fault gouge, the fault must have been upward sharply to pass over Thunder Mountain, because a fault gouge over 60 feet thick should represent a fault of great lateral extent. Also, the contact of the mud with the underlying flow breccia is sharp, and the numerous small faults that would be expected to extend into the walls for some distance from a fault as large as Livingston postulates are not evident, nor can horses of slickensided wall rock like those in other large fault zones be found through the mud.

The ore at the Sunnyside mine occurs as a blanket-like body in highly altered flow breccia and related rock close to the contact with the overlying mud flow. The ore limits are ill defined and must be determined by assays or sampling. As exposed in the underground workings, the ore body plunges north at about 50 east of the rolling contact of the mud. The better ore appears to follow fracture zones that strike east of north and have nearly vertical dips. The rock constituted the ore is almost entirely oxidized, although in a few places patches of residual pyrite remain. Very fine gold can be panned from the better grade ore. The gold appears to have been deposited beneath the mud, which acted as a dam to upward-moving solutions, because, although traces of gold can be found in the altered rocks beneath the mud almost anywhere in the mine, all the good ore is found within a few feet of the mud contact. The fact that the mud in places contains considerable gold and silver adds additional support to this evidence. For example, in the two longer crosscuts west on the Sunnyside level the mud is greatly silicified, and a sample taken from the point marked no. 1 on figure 19 contained 0.12 ounce of gold and 2.36 ounces of silver to the ton. However, the highest grade ore is not found in the sections at the contact, but generally 5 to 10 feet beneath it (fig. 19). Thus, it appears that after the gold was deposited it

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41.
beneath the mud dam much of it migrated several feet downward and was concentrated in layers from 3 to over 25 feet thick. The migration may have been in part mechanical, but probably was largely a chemical process. A small amount of water continually flows down between the contact of the mud and the underlying rocks. Furthermore, much manganese oxide is present in the ore, and, as pointed out by Emmons, gold, although one of the most insoluble metals, can be taken into solution and transported in the presence of manganese and chlorine, and chlorine occurs in all mine waters that have been tested.

The average gold content of the ore beneath the mud is not known. Only a small amount of development work has been done in the ore, and it has been directed along the higher-grade shoots. Several holes have been drilled from the surface, but they are widely spaced. Sampling of the underground workings indicates that the ore runs from less than 0.03 ounce to over 0.5 ounce to the ton, and that the average tenor of large blocks of ground ranges from 0.15 to 0.25 ounce to the ton. Samples were cut by Shonen from ten places on the Sunnyside and intermediate levels, shown by numbers on Figure 19. They probably are not representative of the ore from the mine, as several of them were taken below the horizon of the mineable ore. Sample No. 10 was cut from a working face.

Assays of samples from Sunnyside and intermediate levels of Sunnyside mine
(E. T. Erickson, analyst)

<table>
<thead>
<tr>
<th></th>
<th>Gold (ounce)</th>
<th>Silver (ounce)</th>
<th>Gold (ounce)</th>
<th>Silver (ounce)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.12</td>
<td>2.36</td>
<td>0.58</td>
<td>0.58</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>1.37</td>
<td>0.14</td>
<td>0.43</td>
</tr>
<tr>
<td>3</td>
<td>0.12</td>
<td>1.16</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>0.58</td>
<td>0.32</td>
<td>0.56</td>
<td>0.51</td>
</tr>
<tr>
<td>5</td>
<td>0.67</td>
<td>0.50</td>
<td>0.62</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Mineralized mud.

Venable

The Venable mine joins the Sunnyside property on the north. There are a cabin, a Chili ball mill, two tunnels, a shaft, and numerous cuts on the property. The milling equipment suggests that some ore has been mined and treated, but the extent of the production is not known. The principal tunnel noted is just above the mill, is several hundred feet long, and trends 33° E. A raise from it reaches the surface on the flat divide east of the cabin. The tunnel is partly caved and contains considerable water. The rock at the Venable resembles that containing the ore at the Sunnyside mine. It appears to dip gently north, though the stratification is not well defined. On the dump there is some rock like the mud-flow at the Sunnyside, in places the flow broccoli has slight green stains, but no sulphides were seen. There is another tunnel 50 feet down the hill, but it is caved within 30 feet of its portal.

Standard

The Standard mine is 2,000 feet west of Thunder Mountain and about 3,000 feet southeast of the Dewey. The deposit was located in 1903 by J. E. Casley and

Joseph Chatham, and was later sold to the Standard Mining Company. Several tunnels were driven and a camp established. The buildings are now in disrepair, and in 1933 the tunnels were inaccessible.

The principal tunnels are at the foot of a steep scarp that marks the west front of Thunder Mountain. West of the scarp the terrain is relatively flat, but is characterized by several depressions, some of which contain small lakes. Thunder Mountain is made up largely of flow breccia, but a short distance above the portal of the Standard tunnel there is an irregular-shaped area of silicified mud that resembles the mud at the Sunnyside. The mud is believed to be a remnant left by the slump faults that attended the land sliding at the head of Mule Creek. This interpretation is supported by information regarding the underground workings. The principal tunnel is said to have been run through mud to a rhyolite (flow breccia) contact, and a drift from it which was driven north along the contact came out at the surface. It is reported that ore along the contact assayed $4 to $5 a ton when gold sold for $20 an ounce.

H-Y

The H-Y mine is about 2,000 feet southwest of the Standard, on the divide between Cornish and Coone creeks (fig. 17). The deposit was located by Jones Fuller, John Lawrence, and John Ferrington in 1901. In 1902, the property was sold to the H-Y Mining Company. Two tunnels were run near the head of Cornish Creek. One of them, the Dakota, is over 300 feet long. In 1903, a shaft 260 feet deep was sunk, and two crosscuts were turned from it. One of the crosscuts, 300 feet long, was driven toward the Standard, and another to the south. A camp, consisting of six or more buildings, was constructed, but is now in a state of disrepair.

The Dakota tunnel was run in flow breccia similar to that at the Sunnyside, but less altered. The shaft was sunk entirely in mud-flow material consisting of mud with numerous boulders of sandstone, shale, flow breccia, basalt, and carbonized wood. There is no record of production from this property.

PLACERS

The placer deposits are all more or less related to glacial and interglacial streams, although re-sorting and additional concentration have taken place up to the present time. The deposits are largely in or near the Edwardsburg district.

Two properties, those of the Big Creek Gold Mines, Inc., and the Smith Creek Hydraulic Company, are the principal placer prospects of the region. In addition, some preliminary test-drilling has been done in the Chamberlain Basin, and numerous small-scale panning and sluicing operations have been undertaken along the beds and on numerous terraces of a number of streams.

The Big Creek Gold Mines, Inc., controls 480 acres of ground in the meadows of Big Creek south of Edwardsburg. In 1929, this ground was tested with the intention of installing a dredge if results warranted.

The Smith Creek deposit is on Smith Creek above its confluence with Big Creek. It comprises 19 placer claims, but until 1934 had been worked only to a very slight extent, because of the difficulties entailed in handling the many large boulders in the deposit. For part of the summer of 1934 C. E. Dimmorn and associates worked the property with drag lines and trucks, but they also had

1/ Neff, C. W., Personal communication.
2/ Idem
3/ Idem
difficulty in handling the boulders. Bell \(^1\) states that incomplete tests of the gravel for a distance of 4 miles along Smith Creek indicates an average value of about 0.04 ounce of gold to the cubic yard. Tests near the mouth of Smith Creek yielded results of about 0.05 ounce to the cubic yard, and several small nuggets were found, one of which Bell states was worth $55, with gold at $20 an ounce.

Chamberlain Basin is a large valley floored with gravel and alluvium. It is accessible by trail from the end of the road at the Golden Rand mine, about 15 to 20 miles distant. An airplane landing field has been constructed in Chamberlain Basin by the United States Forest Service. Several test holes have been sunk in the valley; some of them are reported to show the presence of gold and in some the quantity is reported to have been most encouraging. In addition to Chamberlain Basin there are several other gravel-filled valleys in the northern part of the area included in this report. They are shown in figure 2, but no data are available on their gold content. Apparently they have never been tested.

**ECONOMIC CONSIDERATIONS**

Parts of the extremely large and continuous mineralized zone in the Edwardsburg district have already been mined on a small scale, and it seems likely that as more information is obtained on the gold content further mining will be done, either by selective, small-scalo mining methods or by large-scalo, low-cost operations. In places stibnite is associated with the gold - for example, on the north side of Profile Gap - and it may locally be abundant enough to form a valuable byproduct. At the present time, more adequate sampling is needed along the mineralized zone. No deep testing has been done, and possibly drilling at certain favorable places would be the most effective manner to make preliminary tests.

The same general type of mineralization persists for great distances on the surface in the Edwardsburg district. The horizontal persistence of this type may, with moderate assurance, be considered as indicating that notable changes in the general type of mineralization, except for a shallow zone of enrichment, are not to be expected for at least several hundred feet below the surface, and possibly for several thousand feet.

Several good sized gold-bearing quartz veins have been partly developed in and near the Edwardsburg district. The quartz is likely to be more or less lens-shaped, but in some properties it is continuous for 1,000 to 1,200 feet. In sampling or mining the veins, consideration should be given to the fact that the gold is not evenly distributed through the quartz, but tends to be concentrated in shoots.

Some of the deposits containing copper, especially the magnetite veins at Copper Camp, are large and continuous, but on the average appear to be of low-grade. Others - for example, those on Missouri Ridge - are more irregular, but may be of higher-grade.

Deposits of contact-altered limestone should be scrutinized carefully for scheelite (calcium tungstate). The altered limestone, with or without scheelite, is usually abnormally heavy, but if scheelite is present, it can usually be detected as a white or yellowish-white mineral that stays with the heavy concentrate when panned.

Gold deposits in the Challis volcanics cannot readily be distinguished from the altered rock in which they occur. Hence, the likelihood of overlooking valuable deposits is considerably greater than in the pre-Tertiary rocks, where the

\(^1\)Bell, R. N., Mines in the Idaho granite batholith: Min. Truth, Sept. 3, 1929, p. 8
gold and other metals are generally present in quartz veins or in shear zones that have been largely replaced by quartz. To prospect efficiently for gold in the Tertiary volcanic rocks of central Idaho it is therefore necessary to work with a pan, and a certain amount of assaying may be required. Areas of intense alteration, especially areas where clay minerals have been formed in abundance, are favorable for a trial by panning.

Ore deposits in the Challis volcanics are likely to have a wide lateral extent, but less likely to have great vertical continuity. As an example, the ore at the Sunnyside mine is widespread and without definite boundaries, but the gold content decreases sufficiently a few feet vertically below the mud-flow under which the ore occurs to make the rock non-commercial. At the Dewey mine, the mineralization and silicification persisted far beyond the stope ground. Reports are current that the silicified part of Dewey Hill has an average gold content of 0.050 to 0.10 ounce to the ton. However, so far as known, Dewey Hill has never been systematically prospected.

The possible effect of landslides on ore deposits in the Challis volcanics should be considered in prospecting or examining mineralized areas. Because of the weakness of these rocks they will not maintain the steep slopes that are developed by erosion in central Idaho; hence, landslides of several varieties are widespread. Some of the known ore deposits have been directly affected by landslides - for example, the Sunnyside deposit, which has been terminated on the west by the landslide that formed a scarp which partly defines the amphitheater-like basin at the head of Mule Creek. Whether undiscovered offset segments of the ore can be found and mined at a profit is open to question. It is possible that the depressed segments may have been considerably broken and displaced by the recurring land movements that have affected the area. On the other hand, because of the additional strength imparted to the rocks by intense silicification, Dewey Hill has not been appreciably affected by the recent landslides, which passed around the hill. It is not known to what depth Dewey Hill was affected by older landslides, but apparently mining was extended to a depth of 240 feet without insurmountable difficulties.

Several enclosed valleys or basins floored by gravels and related rocks are distributed throughout the northern part of the area described in this report. Most of them are of considerable extent, but so far as known few of them have been tested for their gold content. The deposits of some favorably located basins of this general type - for example, those near Warren and Elk City - have been successfully mined by dredging and other placer methods.
GEOLOGIC MAP OF THE PROFILE GAP AREA, VALLEY COUNTY, IDAHO

MINES AND PROSPECTS
- Red metal
- Profile - Yellow Pine
- Sam Wilson
- Lotspiech

Geology and Topography by
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