STATE OF IDAHO

Len Jordan, Governor

IDAHO BUREAU OF MINES AND GEOLOGY

A. W. Fahrenwald, Director

RECONNAISSANCE GEOLOGY AND ORE DEPOSITS OF THE MINERAL DISTRICT,
WASHINGTON COUNTY, IDAHO

by

Alfred L. Anderson and Warren R. Wagner
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>1</td>
</tr>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Scope</td>
<td>2</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>2</td>
</tr>
<tr>
<td>Previous geologic work</td>
<td>2</td>
</tr>
<tr>
<td>Geography</td>
<td>3</td>
</tr>
<tr>
<td>Location and accessibility</td>
<td>3</td>
</tr>
<tr>
<td>Topography</td>
<td>4</td>
</tr>
<tr>
<td>Climate</td>
<td>4</td>
</tr>
<tr>
<td>Geology</td>
<td>4</td>
</tr>
<tr>
<td>General statement</td>
<td>4</td>
</tr>
<tr>
<td>Permian (?) volcanics</td>
<td>5</td>
</tr>
<tr>
<td>Triassic (?) sedimentary rocks</td>
<td>6</td>
</tr>
<tr>
<td>Terrace gravels (Quaternary).</td>
<td>7</td>
</tr>
<tr>
<td>Intrusive rocks</td>
<td>7</td>
</tr>
<tr>
<td>Diorite</td>
<td>7</td>
</tr>
<tr>
<td>Quartz diorite</td>
<td>7</td>
</tr>
<tr>
<td>Granodiorite porphyry</td>
<td>8</td>
</tr>
<tr>
<td>Lamprophyre (?)</td>
<td>8</td>
</tr>
<tr>
<td>Diabase</td>
<td>9</td>
</tr>
<tr>
<td>Basalt porphyry</td>
<td>9</td>
</tr>
<tr>
<td>Structure</td>
<td>9</td>
</tr>
<tr>
<td>Folds</td>
<td>10</td>
</tr>
<tr>
<td>Domes</td>
<td>10</td>
</tr>
<tr>
<td>Faults</td>
<td>10</td>
</tr>
<tr>
<td>Ore deposits</td>
<td>11</td>
</tr>
<tr>
<td>History and production</td>
<td>11</td>
</tr>
<tr>
<td>Character of deposits</td>
<td>12</td>
</tr>
<tr>
<td>Distribution</td>
<td>13</td>
</tr>
<tr>
<td>Structural relations</td>
<td>13</td>
</tr>
<tr>
<td>Mineralogy</td>
<td>14</td>
</tr>
<tr>
<td>Size</td>
<td>14</td>
</tr>
<tr>
<td>Distribution of ore</td>
<td>15</td>
</tr>
<tr>
<td>Tenor of ore</td>
<td>15</td>
</tr>
<tr>
<td>Origin</td>
<td>16</td>
</tr>
<tr>
<td>Thermal aspects</td>
<td>16</td>
</tr>
<tr>
<td>Depth of formation</td>
<td>16</td>
</tr>
<tr>
<td>Igneous associations and age</td>
<td>17</td>
</tr>
<tr>
<td>Outlook</td>
<td>18</td>
</tr>
<tr>
<td>Mines and prospects</td>
<td>18</td>
</tr>
<tr>
<td>Black Hawk</td>
<td>19</td>
</tr>
<tr>
<td>Silver Still</td>
<td>20</td>
</tr>
<tr>
<td>Silver Bell</td>
<td>21</td>
</tr>
<tr>
<td>King</td>
<td>22</td>
</tr>
<tr>
<td>Egan</td>
<td>22</td>
</tr>
<tr>
<td>Boone</td>
<td>23</td>
</tr>
<tr>
<td>Enterprise</td>
<td>24</td>
</tr>
<tr>
<td>Liberty</td>
<td>24</td>
</tr>
<tr>
<td>Black Jack</td>
<td>25</td>
</tr>
<tr>
<td>Condor (Jessie)</td>
<td>25</td>
</tr>
<tr>
<td>Tate</td>
<td>26</td>
</tr>
<tr>
<td>Dennett Creek</td>
<td>26</td>
</tr>
<tr>
<td>Azurite</td>
<td>26</td>
</tr>
</tbody>
</table>
ILLUSTRATIONS

Plate 1. Bennett Creek Valley.......................... 4

Figure 1. Index map showing topography and location of the mineral district and claim groups..... 3
2. Geologic sketch map of the mineral district.............. 5
3. Claim map, mineral district, Washington County, Idaho.......................... 18
4. Geologic sketch map of the lower Maria adit level.......................... 18
5. Map of underground workings at the Black Hawk mine with geology on the Blacksmith and Ore Chute adit levels.......................... 19
6. Geologic map of underground workings at the Silver Still mine.......................... 20
7. Geologic sketch map of the Intermediate adit level, Silver Bell mine.......................... 21
8. Geologic map of the King adit.......................... 22
9. Geologic sketch map of the underground workings at the Egan mine.......................... 22
10. Longitudinal section of the Egan mine showing stopes (after U. S. Bureau of Mines).............. 22
11. Plan and longitudinal section of the Boone mine; geology on lower adit level.......................... 23
12. Geologic sketch map of the Enterprise mine.......................... 24
13. Geologic sketch map of the lower adit at the Black Jack mine.......................... 25
14. Geologic map of the workings on the Condor (Jessie) group.......................... in back
The mineral district near Snake River and the Oregon line in western Washington County, Idaho, has produced more than a million ounces of silver and appreciable amounts of copper and lead. The entire production has come from a group of silver-bearing lodes containing fine-grained sulfides—pyrite, tetrahedrite, chalcopyrite, galena, and sphalerite and locally also marcasite, wurtzite, and sulfosalts—in a calcite gangue. These lodes replace altered Permian (?) volcanic rock along broad zones of complexly fractured rock. A second group of quartz-tourmaline veins with pyrite, chalcopyrite, and sphalerite in fissured and fractured diorite and quartz diorite has not been productive. The silver-bearing lodes have a restricted vertical range and appear to be the product of rather shallow, low-temperature, probably Tertiary mineralization. The quartz-tourmaline veins have a greater vertical range and appear to be the product of a more deeply seated and higher temperature mineralization of probable late Mesozoic age. The productive lodes are up to 60 feet wide, but the ore shoots in them are generally narrow, ordinarily no more than a foot or two wide, and appear to bottom within 200 feet of the present surface. Much of the ore mined has been somewhat enriched by supergene processes.

The geologic setting has not been entirely worked out. The district is underlain by a perplexing assemblage of folded and faulted sedimentary and volcanic rocks which are altered and intruded by igneous rocks of several kinds and ages. The volcanics consisting of flows and pyroclastics have been regarded as Permian, but the upper part of the assemblage has yielded Jurassic fossils. The sedimentary rocks consist of a succession of phyllic slates and intercalated beds of limestone and gypsum presumed to be of Triassic age. The oldest intrusive is a dioritic stock of post-Triassic age, which appears to be intruded by quartz diorite, a probable outlier of the Idaho batholith (Cretaceous). Both are cut by numerous dikes of diabase and by a few dikes of basalt porphyry, lamprophyre, and granodiorite porphyry. The diabasic and basaltic dikes have been regarded as feeders of flows of Columbia River basalt (Miocene), stripped from the immediate area by erosion. The folded volcanic and sedimentary rocks locally dip northwest and form the flank of a broad dome. There are two prominent fault systems, each of which has directed mineralizing solutions. One trends east-northeast, less commonly north-northwest, and contains the copper-tourmaline veins; the other trends west-northwest and contains the silver lodes. The diabasic and basaltic dikes have been intruded along the west-northwest faults and a set of northerly trending faults.
INTRODUCTION

Scope

This report embodies the results of a two-weeks study in July, 1945, of the silver-copper deposits of the Mineral district in Washington County, Idaho. During these two weeks all the underground workings of accessible mines and prospects were studied and mapped in detail, but the limited time did not permit any detailed surface mapping nor did it afford much opportunity for unraveling the highly complicated stratigraphic and structural relationships. Whereas sufficient data were accumulated for a fairly comprehensive report on the nature and characteristics of the mineralization, only the most sketchy information can be presented on the more general features of the geology. It is hoped that this report, incomplete as it may be, may prove useful until a more complete study may be made of the district and the larger surrounding region.

Acknowledgments

Most sincere appreciation is extended to Mr. L. B. Murphy, who provided board and lodging at this isolated, virtually deserted mining camp and thus made the study possible, to Mr. J. B. Growen, who made available maps he had prepared of most of the properties, to Mr. Allen C. Merritt, who provided a copy of the claim map he had surveyed, and to others who assisted in the work in one way or another. While in the field the writers shared the work of underground mapping and surface reconnaissance and later worked together on the preparation of polished sections of ores and thin sections of rocks. On the senior author (A. L. Anderson) has fallen the burden of the laboratory studies, the drafting of most of the maps, and the actual writing of the report. The geologic interpretations and conclusions are those of the writer and do not necessarily reflect the views of Mr. Wagner.

Previous Geologic Work

The district was visited at the turn of the century by Waldemar Lindgren, several years later by H. W. Turner, and in 1923 and for some years later by D. C. Livingston. Each of these men has provided some information on the geology of the area and its mineral deposits. The references to their
published works are listed below. Some bits of information are also contained in some of the mineral Resources of the United States, published until 1923 by the U. S. Geological Survey and since then by the U. S. Bureau of Mines, as the Minerals Year Book from 1932 to the present.


GEOGRAPHY

Location and Accessibility

The Mineral district is on Dennett Creek near the west border of Washington County about 4 miles from the Snake River and the Oregon line (Fig. 1). It is confined almost entirely to Secs. 9 and 10, T. 16 N., R. 64 W., Boise meridian, and is less than 2 miles from the iron deposits on Iron Mountain at the head of Dennett Creek.

The district is 47 miles from Weiser, the county seat, by way of Huntington, Oregon. It is perhaps about half as far via Iron Mountain, but the roads from Iron Mountain to Mineral are too steep for most trucks and automobiles and have not been kept in repair. The district therefore is most conveniently reached by the down-river road from Huntington, with ferry connection 20 miles below with the road up Dennett Creek. (Fig. 1) A road about 4 miles south of the Snake River district on the Idaho side ascends Wolf Creek but, because of broken bridges, this road could not be travelled in 1945. Even with the bridge in repair the route over good highways via Huntington is preferred to the shorter but more strenuous drive up and over Wolf Creek summit.

The district has easy access to the branch line of the Union Pacific Railroad that extends down the Snake River from Huntington to Robinette (Fig. 1). The road up Dennett Creek to Mineral has an easy grade and is well maintained. The main obstacle to transportation of ore to the railroad is the crossing of the river by ferry.
Fig. 1. Index map showing topography and location of Mineral district and claim groups.
Topography

The district is in rather rugged canyon country, though the canyons are neither so deep nor so rugged as they are farther north where the Snake River flows past the Seven Devils Mountains in a canyon deeper and narrower than the Grand Canyon of the Colorado. From an altitude of 2,000 feet at the mouth of Dennett Creek the slopes rise steeply for about 2,000 feet or more and then incline more gradually to altitudes above 6,000 feet in the headwaters region, attaining a maximum altitude of 6,496 feet on Iron Mountain (Fig. 1). As shown on Plate 1, the slopes are steep and largely void of vegetation, except for grass and sage brush and occasional scattered pines, well back from the river. The many gulches heading on and around Iron Mountain provide Dennett Creek with a good supply of water, ample for all mining and domestic activities.

Climate

The district has a genial climate. Winters are generally mild and there is little snow, except on upper slopes. Snow fall at lower levels, the cover normally does not remain long on the ground. The winter and spring months comprise the rainy season. Summers are dry and ordinarily hot. However, the heat of the day is tempered at night by cool, down-valley breezes that descend from Iron Mountain as soon as the sun sinks over the western canyon wall. The climate facilitates mining activities at all seasons of the year. Although rainfall is too light for vegetation other than grass and sage brush at lower levels, the amount increases with the altitude and Iron Mountain is well forested.

GEOLOGY

General Statement

The district contains a baffling assemblage of altered sedimentary and volcanic rocks which are folded and complexly faulted and intruded by igneous rocks of several kinds and ages. The volcanic rocks, flows and pyroclastics, have been regarded as of Permian age, and a succession of phyllic slates and intercalated beds of limestone and gypsum presumably above the volcanics, as Triassic; but the discovery of Jurassic fossils in tuff beds apparently near the top of the volcanic series introduces some uncertainty as to actual ages and structural relations.
DENNETT CREEK VALLEY

Picture shows the steep-sided valley of Dennett Creek in the foreground and the upper canyon wall on the west (Oregon) side of Snake River in the distant background. The old town of Mineral is hidden from view but some of the mine dumps on the south side of Dennett Creek are visible on the slope across the creek.
Permian (?) Volcanics

The volcanics may be divided into three fairly well-defined units consisting of a lower group of andesitic rocks, a middle latitic member, and an upper group of tuffaceous rocks, in part fossiliferous. Except for the latitic flows, these rocks were not differentiated from the sedimentary rocks in mapping (Fig. 2).

The rocks classified as andesitic in composition have been so altered by mineralizing fluids that it is not clear whether they consist entirely of flows or include also tuffs and agglomerates. They form the mass of undifferentiated rocks south of Dennett Creek and are the host for all the formerly productive mines of that area. The rocks are porphyritic and more or less conspicuously greenish in color, a feature which prompted Lindgren.


To describe them as a heavy series of old greenstones and tuffs. Few of the feldspars are determinable and textures are in considerable part obscure, but the remnants of original grains that remain among the chloritic and sericitic alteration products suggest that the rock was andesitic and contained plagioclase, hornblende or augite, and perhaps biotite among the larger grains. The matrix is indeterminate. Near mineralised areas the rock contains calcite and disseminated pyrite.

The latitic member crops out prominently along the upper slope and crest of the ridge north of Mineral, extending eastward from the forks of Dennett Creek well up into the headwater region where it ends against the large body of quartz diorite (Fig. 2). The member is several hundred feet thick and in part forms a dip slope on the north side of the ridge. The rock has a distinctive light-gray color in contrast to the mottled, greenish color of the poorly exposed andesitic rocks. Most of the latitic rock is conspicuously porphyritic and contains abundant, more or less highly altered plagioclase and in some places also orthoclase phenocrysts and completely altered hornblende or biotite grains in a fine-grained feldspathic groundmass composed chiefly of orthoclase and to lesser extent, of plagioclase and in-filtered quartz, apparently added from mineralizing fluids. Some of the rock may have enough quartz to justify the name of quartz latite, but most of it is more appropriately classed as latite. This is the rock which Livingston designated as rhyolite.

Fig. 2. Geologic sketch map of the Mineral district, Washington County, Idaho.
As the unit above the latite was mostly outside the area of mineralization, it received little attention and little is known of its makeup. The rocks observed were largely tuffaceous and might be classed in part as calcareous andesitic or rhyolitic tuffs. It was in some of these rocks that the Jurassic fossils were found.

The age of these rocks is not definitely established. The andesitic rocks are strikingly similar to the andesitic rocks which the writer has seen in the Seven Devils area and these are known to be of Permian age. Because of their resemblance to the Permian volcanics in the Seven Devils area, Livingston /\ regarded those at Mineral also as Permian and perhaps rightly so.

---


The presence of Jurassic fossils in the upper tuffaceous members may reflect a structural accident, the result of superposition of younger rocks on the older as a consequence of faulting. In any event much more study is needed over a broad area before definite age commitments can be made.

Triassic (?) Sedimentary Rocks

The sedimentary rocks are mostly outside the mineralized area, except on Iron mountain, and received no particular attention during the reconnaissance. They are well exposed below the forks of Dennett Creek and form particularly conspicuous outcrops on the slope west and just above the mouth of North Fork of Dennett Creek. The belt curves around the north side of the district and the rocks reappear on the high ridge overlooking the upper course of Dennett Creek.

The rocks are chiefly phyllitic but contain some thin beds of gypsum and a relatively thick bed of limestone. Lindgren /\ refers to the rocks as

---

/\ Twenty Second Ann. Rept., Pt. 2, op. cit. p. 754

fissile clay slates with an intercalated bed of limestone, and Livingston /\

---

/\ Idaho Bur. Mines and Geology Pamph. 13, op. cit. p. 18

speaks of schists, limestones, gypsum formation, and slates.

These beds are regarded by Livingston as Triassic. They show a striking resemblance to phyllites and limestone of that age which the writers have seen farther north along the Salmon and Clearwater rivers.
Terrace Gravels (quaternary)

Terrace gravels occur at several places along Dennett Creek, forming small bench caps 50 feet or more above the present level of the stream (Fig. 2). These gravels accumulated during an earlier stage of valley development and have been left behind as the stream entrenched in its formerly higher and broader valley floor.

Intrusive Rocks

The intrusive rocks consist of diorite, quartz diorite, diabase, lamprophyre, granodiorite porphyry, and basalt porphyry. The diorite and quartz diorite are in bodies large enough to be classed as stocks, the others occur as dikes. The ages of these intrusives are not exactly known. The diorite and quartz diorite are older than the dikes and all are younger than the sedimentary and volcanic rocks, which they intrude.

Diorite.—As shown in figure 2, the diorite is exposed on both sides of Dennett Creek beginning just above the forks and extending upstream about a mile where it abuts against the body of quartz diorite. On the south side of the valley the diorite is in contact with the andesitic volcanics; on the north side, with the thick flow of latite.

The diorite is mostly dark gray, medium-grained, and is composed largely of zoned plagioclase and augite with variable but generally much smaller amounts of hornblende, biotite, quartz, magnetite, and sphene, and occasional grains of orthoclase. The plagioclase apparently has inner zones as calcic as labradorite and outer zones as sodic as andesine. Its grains are little altered but those of augite, hornblende, and biotite are generally changed to chlorite, epidote, and calcite, and in large part are recognized only by grain outlines. The rock is more altered near mineralized areas than elsewhere and where most extensively altered also contains sericite, much calcite, and some pyrite.

Although the evidence is not wholly conclusive, certain structural and mineralogical relationships suggest that the diorite may have been intruded ahead of the quartz diorite. Tending to confirm this relationship is the abrupt way in which the diorite ends against the quartz diorite, as though cut off by it, with some prongs of the quartz diorite actually extending into the diorite (Fig. 2). Also in support of this evidence is the way in which the diorite next to the quartz diorite appears to be enriched in magnetite, quartz, and epidote, a relationship which suggests the work of emanations from the quartz diorite magma. The diorite can be no older than Jurassic and is more likely Cretaceous.

Quartz diorite.—Exposed in the headwater drainage of Dennett Creek (Fig. 2), the quartz diorite is a part of a larger mass that extends beneath much of Iron Mountain and for some distance to the north and east. This body has been responsible for much contact metamorphism on Iron Mountain.
The quartz diorite is easily distinguished from the diorite. It is appreciably lighter in color and, except close to the contact, is much coarser in grain size. Most of the rock is light rather than dark gray and moderately coarse-grained rather than medium-grained. It contains only about 10 per cent dark minerals, which are represented by partly altered hornblende and biotite, about 20 to 30 per cent quartz, and 60 to 70 per cent of somewhat sericitized plagioclase (andesine) plus a little orthoclase, magnetite, apatite, and zircon.

This rock is very similar to some of the diorite and quartz monzonitic rock exposed elsewhere in the State in and about the Idaho batholith and may be one of the bodies emplaced near the close of Cretaceous time.


Granodiorite porphyry.—The granodiorite porphyry was noted as a single dike on the ridge above the Jessie workings. It there cuts the diorite close to the quartz diorite contact.

The rock is conspicuously porphyritic with rather numerous phenocrysts of andesine, hornblende, biotite, and quartz measuring up to 3 mm. long in a finely crystalline, dark, brownish-gray groundmass composed of orthoclase, quartz, and possibly some plagioclase. The rock also contains considerable amounts of magnetite, much chlorite, a little pyrite, and some large grains of epidote.

The granodiorite porphyry shows the effects of quick chilling during consolidation and thus must have been intruded into the diorite after that body had become cold. It may probably be correlated with the early Tertiary intrusives which the writer has recognized elsewhere in Idaho.

Lamprophyre (?).—A dike tentatively identified as lamprophyre crops out high of the divide north of Dunnett Creek. It resembles the basalt porphyry in its dark color and porphyritic character, but otherwise has the characteristics of a lamprophyre with an exceptionally high content of intratelluric phenocrysts carried upward from a deep magma source. The intertellaric phenocrysts include numerous partly resorbed crystals of plagioclase and hornblende intermingled with small but more numerous crystals of greenish, non-intratelluric crystals of hornblende in a microgranular groundmass composed of about equal amounts of sodic plagioclase and orthoclase and a little quartz. The rock also contains some small and large crystals of sphaene.

The rock shows considerable mineralogic resemblance to the granodiorite porphyry and the two are probably related genetically.
Diabase.-- Dikes of diabasic characteristics are commonplace in the district and are generously exposed on the surface and in mine workings. The dikes are a few feet to a few tens of feet wide and occur abundantly in the diorite, quartz diorite, and in the bordering volcanics.

The rock is dark gray to nearly black, is fine grained in the smaller dikes, and of medium grain in the larger. Its texture is more or less typically diabasic and its minerals are labradorite, augite, magnetite, and apatite, the labradorite composing about 60 per cent of the rock, the augite 30 to 35 per cent, and the magnetite 5 per cent or more. The apatite forms long needles and rods and is always a conspicuous constituent. Unlike most of the other intrusive rocks the diabase is remarkably free of alteration products.

As the dikes cut the diorite and quartz diorite and are intruded along and across the veins and lodes, they are comparatively young. Earlier workers have classed the dikes as basalt dikes, and have regarded them as feeders to the flows of Columbia River basalt. If related to the basaltic flows, the diabasic dikes should be of Miocene age. Actually, the diabase has no great resemblance to the surface flows and may not be related to them.

Basalt porphyry.-- Several narrow dikes of basaltic porphyry were observed, one in the raise in the Silver Still mine (unmapped), the others near the crest of the ridge north of Derritt Creek. That in the Silver Still mine is only about 10 inches thick.

The basalt porphyry is conspicuously porphyritic and contains numerous tabular, glassy labradorite crystals up to an inch long in a grayish, finely crystalline groundmass composed of plagioclase grains and a little olivine, augite, and magnetite.

The basalt porphyry is identical to the porphyritic basalts of the region and the dikes are probably feeders to the flows removed from the immediate area by erosion.

Structure

The story of the structural development is not wholly complete, but the available data point to an early period of folding accompanied perhaps by some faulting, to a later general doming, and to several subsequent epochs of faulting.

Folds.-- The volcanic and sedimentary rocks are tilted and strike about N. 65° E. at the west border of the map (Fig. 2) and about N. 80° E. along the north border. But, the continuity of the strata is repeatedly interrupted by faults which cause local departures. The dip, however, is invariably north
at angles averaging about 35°. The district thus appears to be on the
north limb of a complexly faulted anticline of general east-northeast trend.
The other flank of the anticline was not seen, but the local relations suggest
that the anticline is a broad one. Perhaps the rather rigid volcanics flows
did not permit close folding even though the forces that produced the folding
were powerful enough to cause recrystallization of the limestone and con-
version of the shale to phyllite and slate.

The presence of Jurassic tuffs above the thick flow of latite on the
slope descending to the North Fork of Bennett Creek and apparently stratigra-
phically below the Triassic (?) limestone, gypsum, and phyllite across
the creek may introduce a structural problem involving possible overthrust-
ning or low-angle normal faulting.

As the Jurassic tuffs appear to be involved, the folding can be no
older than Jurassic. It preceded the intrusion of the diorite and quartz
diorite and is probably a product of the Sierra Nevadan orogeny of late
Jurassic time.

Domes.—In addition to the folding the rocks also appear to have been
warped into a broad, elongated dome whose axis is about parallel to the
trend of the fold. As a consequence the limestones and associated rocks tend
to encircle the district, a relation which probably explains the curving
trend of those rocks on the west, north, and east.

The significance of the doming is not entirely clear. As the diorite
stock appears to occupy the more central part of the dome, one might infer
that the intrusion of the diorite caused the doming. On the other hand the
dioritic intrusion might have taken advantage of and thus have been localized
by the domed structure.

Faults.—There appear to be three fault systems, reflecting perhaps
as many separate structural disturbances. Two of these systems are im-
portant because of their control on mineralization; the third of minor
consequence, is post-ore.

In one system the faults of the more prominent set strike east-northeast
and dip steeply north, whereas the faults of the complimentary set strike
somewhat west of north. The direction and amount of displacement on these
faults was not learned. There is much gouge on some faults.

In the second system the more prominent faults trend west-northwest
to northwest and dip steeply north to northeast. The complimentary northeast
set is rarely developed. Movement on these faults has produced broad
zones of complexly fractured rock, in part with several principal planes of
movement. Whereas the faults of the first system are largely confined to the
intrusive diorite and quartz diorite, those of the west-northwest system are
restricted to the volcanic rocks on either side of the diorite.
The post-ore faults have a northerly trend and steep dip, either east or west. Several of the larger faults are shown in Fig. 2. Those which cut the ore cause offsets of no more than a few inches. These faults have directed intrusion of diabase and basalt porphyry dikes. The diabase, however, has also taken advantage of the west-northwest set of faults and may lie in or alongside the dikes.

Because of insufficient data, dating the faults is difficult. Those of west-northeast trend have a pattern similar to that produced by differential transmission of stress through the Idaho batholith during the Laramide orogeny, but the same pattern would have been produced by similarly directed stresses associated with the earlier Sierra Nevada disturbance (late Jurassic). As the faults contain veins interpreted as related genetically to the quartz diorite (probable outlier of the Idaho batholith), they are probably a product of the earlier orogeny.

The west-northwest faults may be dated with even less assurance. Their trend corresponds with that of the early Tertiary faults in Boise Basin.


And they may be of that age. The characteristics of these faults indicate that they were formed under lighter load than those of east-northeast trend and thus later, perhaps after a considerable interval of erosion. The mineralization along then seems to have a Tertiary stamp, but whether early or mid-Tertiary is not determined.

The set of northerly trending faults along which so many diabase dikes have been intruded probably may be closely related in time to the extrusion of the Miocene Columbia River basalt.

ORE DEPOSITS

History and Production

Most of the mineral deposits were discovered in the seventies, but there was little active development until a road was built into the district in the late eighties. Soon thereafter two small smelters were equipped, one in 1889 and the other in 1890, and these remained in operation until the low price of silver in 1893 forced them to close. There was then no activity until 1900 when a new 60-ton smelter was erected and no important production until 1909, when for the next two years as many as six mines were producing
or shipping ore or copper matte. In 1905 mining ceased and the district was dormant until 1918. Several shipments were then made from the Enterprise. These were followed by shipments from the Egan mine for several years thereafter. In 1922 the Egan closed and again there was little activity until 1929 when the Silver Still mine began operations. Work continued at the Silver Still until 1940. Except for a rehabilitation program by the U. S. Bureau of mines during the early war years, the district has been idle.

The district's production is not accurately known but probably exceeds more than a million ounces of silver, 170 tons of copper, and 50 tons of lead. According to Lindgren, the production prior to 1900 was about 600,000 ounces of silver. To this may be added 188,067 ounces of silver in the interval between 1903 and 1905 (U. S. Mineral Resources). These include 81,727 ounces of silver shipped by the Ladd Metals Company. This company also shipped ore and matte containing 261,112 pounds of copper. The output of the Enterprise and Egan mines between 1918 and 1923 was not learned, but the extent of stonoping at the Egan suggests that the quantity of ore mined was considerable. The Silver Still made some shipments in 1929 but the main production did not cease until later when in the seven years from 1934 to 1940 inclusive, the mine shipped ore containing 138,243 ounces of silver, 37,4 ounces of gold, 81,219 pounds of copper, and 109,440 pounds of lead. Accepting Lindgren's total of about 600,000 ounces of silver as the output prior to 1900, and 81,727 ounces and 138,243 ounces for the years of 1903-1905 and 1934-1940 respectively, the total production known to the writers is 926,310 ounces of silver. It is likely that the unknown production of the years from 1918 to 1923 may raise the total above a million ounces.

Character of Deposits

The district contains two, or if enlarged to include Iron Mountain, three fundamentally different and contrasting types of mineral deposits. The ore that has been the source of the silver and small copper and lead production occurs as replacements along complex zones of fracturing and is composed of silver-bearing tetrahedrite, chalcocyprite, and the sulfides of lead and zinc in an abundant calcite gangue (silver-foes). The second,
which has not been productive, comprises quartz-tourmaline veins with chalcopyrite, some gold, but no silver. The deposits on Iron Mountain are the contact metamorphic type and contain magnetite ore with garnet and other silicates in limestone.

The quartz-tourmalinic veins and the contact metamorphic deposits are probably products of the same magmatic source, but the silver lodes apparently belong to an entirely different and unrelated metallization. The magnetite deposits are not discussed further.

Distribution

The two contrasting types of deposits, the silver lodes and the quartz-tourmalinic veins, are not intermingled but occur adjacent to each other. The silver lodes extend along the south side of Bennett Creek for about a mile above the mouth of the North Fork as well as across the lower end of the ridge between the two forks (Fig. 2). The quartz-tourmalinic veins lie immediately to the east and extend from Bennett Creek northward almost to the crest of the high divide, covering a considerable part of the headwater drainages of Bennett Creek. Combined, the deposits are distributed along an east-west belt about 2 miles long and a little less than a mile wide.

Each of the two types of deposits also has a preferred geologic distribution. The silver lodes are apparently restricted to the volcanic rocks on the two sides of the diorite stock, those on the south side in the andesitic rocks and those on the north side mainly in the latite. No deposits were observed in the diorite or quartz diorite. The copper-bearing quartz-tourmaline veins, on the other hand, occur almost entirely in the diorite and quartz diorite. Both types of deposits are exposed in the Silver Still mine on the south side of Bennett Creek, but here as elsewhere the two are not together, the quartz-tourmalinic veins being in the diorite and the silver lodes on the volcanic side of the contact.

Structural Relations

As in character and distribution, the silver lodes and the copper-bearing quartz-tourmaline veins differ also in structural relations. Each has its own structural associations, the silver lodes with the broad complex fracture and fissure zones of west-northwest and northwest trend and the quartz-tourmalinic veins with the fissures and fractures of east-northeast and the complimentary north-northwest trends. The deposits reflect the peculiarities of the controlling fracture system and form replacement lodes along the broad zones of fractured and fissured rock and predominantly fillings along the open, more sharply defined fault fissures.
Mineralogy

The two types of deposits differ as much in their mineralogic characteristics as they do in their structural and stratigraphic relations. Although they contain some of the same minerals, the mineral habits are dissimilar and serve to accentuate the unlikeness of the two types of mineralization.

The silver lodes contain abundant calcite, darkened in most places by very small grains of rather intimately associated pyrite, chalcopyrite, tetrahedrite, galena, and sphalerite. Occurring locally at the Silver Still are also minor amounts of chalcedony, quartz, marcasite, wurtzite, and several other minerals; identified tentatively and in part as enargite and boulangerite. All the metallic minerals are characteristically fine-grained and show a peculiar tendency to form banded, discontinuous concentric structures, suggesting the colloform. Because of the fineness of grain the microscope is necessary to observe the mineral relationships. Much of the calcite is a replacement of the altered volcanic rock and the sulfides, a replacement of the calcite. The sulfides as concentric bands and massive aggregates have been broken up into small fragmented bodies and the fragments cemented and permeated by a younger generation of calcite generally of slightly coarser grain size. As a result of the fine brecciation and the permeation by the younger calcite, the ore has a peculiar mottled or blotchy appearance.

The copper-bearing quartz-tourmaline veins contain abundant quartz and locally much black tourmaline, generally considerable amounts of pyrite and chalcopyrite and in places sphalerite. The tourmaline is common rather finely crystalline, but the other minerals are relatively coarse-grained. The tourmaline occurs as a replacement of the quartz or silicified country rock and in places is engulfed in quartz of somewhat younger age. The sulfides are later and commonly cement or penetrate fragments of the broken tourmaline and quartz. As compared with the same minerals in the silver lode, these show a noticeable lack of any suggestion of banding or concentric structures and a contrastingly large grain size. Most of the veins also contain some calcite in seams cutting sulfides and the earlier minerals.

Size

The two types of deposits differ further in size. As the silver lodes are replacements along broad zones of fractured rock, they are much the larger and may range up to 60 feet wide and some hundreds of feet in length. These zones of fissured and fractured rock, however, are not uniformly mineralized and the stoping ore may be confined to zones a few feet wide, in some places only a foot or two, in other places up to 20 feet or more.

The quartz-tourmalinic veins, which generally have well-defined walls, are usually no more than 3 or 4 feet wide and commonly no more than a few inches. They may not be traced for more than a few tens of feet, in part perhaps because of inadequate exposures and in part because of interruptions
by faulting. In some places the veins are little more than narrow seams and stringers, but locally the seams are so numerous and so closely spaced as to suggest bodies of stockwork characteristics, with dimensions of a few acres.

Distribution of the Ore

The ore in both types of deposits has a rather sporadic distribution. In the silver lodes the ore forms streaks and irregular bunches scattered along and across the broad zones of altered, fractured rock, with the ore shoots along or bordering the principal fractures. These ore shoots tend to form veins a foot or two wide and up to several hundred feet long, one overlapping another and in places forming two or more roughly parallel veins, with low-grade ore between. The ore becomes less conspicuous with increasing depth, noticeable even in the short interval between the upper and lower adits of most of the mines.

The ore minerals in the quartz-tourmaline veins also have a notably bumpy distribution and occur as scattered grains and small irregular masses forming shoots rarely more than 10 feet long. The veins are exposed on the canyon slope over a vertical distance of 2,000 feet and in this distance show no appreciable change in mineral content or habit. The mineralization thus appears to have a much greater vertical range than the silver mineralization.

Tenor of the Ore

The district has not been famed for the richness of its ores. The silver lodes lack the bonanza characteristics generally associated with silver mineralization and the ore mined has been of good but of moderate grade, rarely containing more than 40 ounces of silver per ton. Most of the ore mined in the early days was oxidized or partly oxidized and richer in silver than the primary ore below. According to Turner the average of 27 smelter samples

\[ \text{Econ Geol., vol. 3, op. cit., p. 497.} \]

from the upper ore zone at the Black Hawk mine in 1904 was 28 ounces of silver per ton and 0.9 per cent copper, whereas the average of the sulfide ore below was 10 ounces of silver per ton and 1.25 per cent copper. He wrote that the best stopes had been worked out prior to 1904. This about accords with what Lindgren had to say about the harda several years before when he reported


that the ore was said to contain 25 to 30 ounces of silver per ton and 1 to 2 per cent copper. More recent shipments from the Black Hawk included a 37-ton lot of partly sorted ore which contained 19.25 ounces of silver and 0.005 ounce of gold per ton, 4.2 per cent copper, and 0.4 per cent lead; also a 50-ton lot of unsorted ore with 15.6 ounces of silver and 0.005 ounce of gold per ton, 4 per cent copper, 0.9 per cent lead, and 5 per cent zinc. Data on
most other mines are lacking, but the ore shipped from the Still mine from 1934-1940 inclusive averaged 36.1 ounces of silver and 0.01 ounce of gold per ton, 1.1 per cent copper and 1.5 per cent lead. Probably considerable of this ore was oxidized or partly oxidized and enriched in silver, for much of the ore that remains is unoxidized and is somewhat higher in copper content and lower in silver than that shipped and carries 2 to 3 per cent zinc and up to 3 per cent lead. Sampling has shown that some 10-12 ounce ore still remains in some of the mines, with some bunches of higher grade.

Little information is available on the tenor of the copper-bearing quartz-tourmaline veins. No large bodies of ore have been uncovered and no shipments have been made. Veins that have been properly sampled show low copper and zinc values (a per cent of each or less). The ore carries no silver but does contain appreciable amounts of gold. Turner /reports that /

/Econ. Geol. vol. 3, op. cit., p. 497./

one of the quartz veins rich in zinc at the Jessie carried $10 in gold per ton (gold at $20.67 per ounce).

Origin

Thermal aspects. -- The mineralogic associations of the two types of deposits reflect thermal as well as compositional differences in the mineralizing fluids. The presence of maronsite and wurtzite and of several sulfosalts (all characteristically low-temperature minerals) in the silver lodes indicates that the fluids responsible for that mineralization were not very hot, perhaps less than 150° C. The presence of the maronsite and wurtzite with the pyrite and sphalerite also indicates that the solutions were acidic as well as possessed of low heat. The fine concentric and certainly in part colloform structures even suggest the possibility of some colloidal deposition.

The quartz-tourmaline veins on the other hand were apparently formed at a considerably higher temperature. Tourmaline itself is ordinarily regarded as a high-temperature mineral and indicative of hypothermal (high-temperature) conditions.

Depth of formation. -- The differences in the structural and textural characters of the two types of deposits indicate that one formed at comparatively shallow depth, the other at considerably greater depth, even though the two are now found at about the same level. The silver lodes are those which have the characteristics of rather shallow mineralization, as though formed perhaps within two or three thousand feet of the surface. Their relatively shallow depth of formation is indicated by their presence in broad fracture zones, which are more typical of rock failure under moderately light than under heavy load, extensive brecciation and abundant pore space usually associated with shallow mineralization are lacking, but this lack may result
because the openings were completely filled and the bordering rock replaced by the calcite and the subsequently introduced ore minerals. The fineness of grain also bears on the problem of depth by affording evidence of rapid cooling and crystallization, possible when the solutions are chilled by contact with large volumes of cold, near-surface rock. That the mineralization has a limited vertical range of just a few hundred feet has been demonstrated by mining operations. The silver lodes thus appear to represent a rather unique type of shallow, epithermal mineralization.

The quartz-tourmaline veins show evidence of having formed at greater depth, perhaps a mile or more below the surface. The greater depth is indicated by the characteristics of the fracturing-fissuring rather than extensive fracturing as under light load—and by coarse grain size. The coarse grains may indicate more leisurely deposition, possible when fluids are not chilled by contact with large volumes of cold rock. Canyon cutting has revealed that deposition took place over a considerably greater vertical range than in the case of the silver lodes.

Magmatic associations and age.—The magmatic associations of each of the two types of deposits and the dates at which each was formed are only partly known. This is particularly true of the silver lodes, less so of the quartz-tourmaline veins. As the latter are grouped just within and about the margins of the quartz diorite, they probably had their source in fluids from the same deep source magma as the intruded quartz diorite, escaping from depth after the magma had largely consolidated. They are probably a phase of the same mineralization that gave rise to the contact metamorphic deposits on Iron Mountain. The age of the quartz-tourmaline mineralization therefore depends on the age of the quartz diorite. If the body of quartz diorite should be a late Cretaceous outlier of the Idaho batholith, then the mineralization could be late Cretaceous.

As the silver lodes are grouped on both sides of the diorite stock, there is a temptation to relate the silver mineralization to the diorite. In that case the silver deposits would have to be older than the quartz-tourmaline deposits. The structural relations suggest that the silver lodes were formed nearer the surface than the quartz-tourmaline veins; thus, after erosion had brought the more deeply formed quartz-tourmaline veins to relatively shallow levels. If this is the case, the silver lodes cannot be related genetically to the diorite. The lodes being younger would be expected to cut both the diorite and the quartz diorite. That they do not do so may be explained by the fact that the weaker volcanic rocks were more susceptible to structural failure under near-surface conditions than the stronger, more rigid intrusive rocks. Hence the dioritic rocks escaped fracturing at the time and received no ore. The silver mineralization apparently can be related to neither the diorite nor quartz diorite nor to the later diabasic intrusives, which were injected along fractures produced during a subsequent deep-seated crustal disturbance. The silver deposits have some of the markings of Tertiary mineralization but whether of early or mid-Tertiary is not entirely evident. The deposits are quite unlike any of the deposits of Tertiary age known elsewhere in Idaho. The problem of age and magmatic association needs further study.
OUTLOOK

The district has some promise of continued small production. With favorable metal prices and low production costs some of the silver-bearing lodes may continue to invite attention, but any work program should take into consideration the fact that most of the past production has come from ore whose value had been somewhat enhanced by supergene enrichment. As verified by the exploration program of the U. S. Bureau of Mines, the ore shoots apparently terminated on or above the lower adit levels and apparently in most, if not all places within 200 feet of the present surface. Only the ore of highest grade was mined and that for the most part was confined to narrow, more or less closely spaced shoots. There remains considerable unmined low-grade, which below the oxidized zone should be amenable to flotation concentration. Consideration might well be given to the possibility of developing large bodies of such ore, workable perhaps under the more efficient mining and concentration methods of the present day.

There is less to be said about the future of the so far unproductive copper-bearing quartz-tourmaline veins in which ore shoots of size attractive to the miner have not been found. Attention, however, might be directed to certain broad, oval-shaped areas of fractured rock which contain numerous, more or less closely spaced stringers and small veins with copper and zinc minerals. Whether or not the deposits are large enough and the ore rich enough for large-scale, low-cost operation can be known only after thorough exploration.

MINES AND PROSPECTS

Marin

The Meris is on the south side of Bennett Creek just across from the old town of Mineral (Fig. 2). The mine is one of those worked in the early days and according to Lindgren the production then was 150,000 ounces of silver. So far as could be learned, there has been no production since. The development has consisted of several adits over a vertical range of 200 feet, but all, except the lowest, which was reopened by the U. S. Bureau of Mines (Fig. 4), are inaccessible.

The lowest adit has been driven through diorite into bleached, extensively chloritized and locally sericitized volcanic rock and has exposed broad zones of complexly fractured rock, directed by faults of N. 45° W. to No. 60° W. trend and steep northeast and southwest dip (Fig. 4). The distribution of the faults suggests two main, rather closely spaced zones of fracturing, perhaps linked together by minor zones of oblique fractures. The mineralization is confined to the zones of complexly fractured rock and is indicated by the presence of irregularly scattered, small bunches of fine-grained sulfides.
Fig. 4. Geologic sketch map of the lower Maria adit level.
According to Lindgren, the Maria contained a fairly well-defined vein from 2 to 4 feet wide which dipped northeasterly, the dip decreasing to 20° in depth. Apparently the vein lost its identity as such before reaching the lowest adit level where it may be recorded merely as a zone of fractured, mineralized rock.

The small bunches of sulfides exposed on the lowest adit level are composed largely of pyrite but they also contain considerable chalcopyrite and generally small amounts of tetrahedrite, galena, and sphalerite, all fine-grained and intimately associated with calcite gangue. Most of the sulfides are intricately intergrown in peculiar concentric masses in fragmented bands or as microscopic, hoop-like rings. The ore mined in the early days contained 1 to 2 per cent copper and 25 to 30 ounces of silver per ton. Some of the specimens of richer ore assayed as much as 0.28 ounce of gold and 55.92 ounces of silver per ton. Apparently the work of the U.S. Bureau of Mines failed to find ore of commercial grade on the bottom level.

Black Hawk

The Black Hawk is on the south side of Bennett Creek just above the Maria (Figs. 2 and 3). It was one of the principal producers in the early days, being credited with 200,000 ounces of silver. Production since was not learned. Its workings are more extensive than at most of the other mines and consist of 7 adit levels, all of which are shown in Fig. 5, the Ore Chute adit by itself. Two of the adits, the Ore Chute and the Blacksmith Shop, were reopened by the U.S. Bureau of Mines and hence were accessible for geologic study and mapping.

As shown in figure 5 the open adits are in altered volcanic rock, but the Ladd and apparently the lower adit pass through diorite rock before entering the volcanics. The only other rocks exposed are two diabase dikes in the far end of the Blacksmith Shop adit, one of which shows to best advantage on the Intermedicate level about 22 feet above.
Fig. 5. Map of underground workings at the Black Hawk mine with geology on the Blacksmith Shop and Ore Chute adit levels.
The volcanic rocks are altered and fractured much the same as at
the Kariu, but some of the more prominent faults trend in a north-northwesterly
direction. Most of the fractures show evidence of mineralization and commonly
contain scattered small bunches of sulfides. There are, however, two well-
defined veins 3 to 6 feet wide exposed on the Intermediate level just above
the Blacksmith Shop adit level, both of which strike about N., 70° W., and dip
60° to 75° NE. They apparently abut against the diabase dikes, which strike
about N., 200° W. The veins have been stoped and nothing much was learned
of their character. The main ore bodies apparently were to the west of the
Blacksmith Shop adit; and, judging from the position of the adits and stopes,
the ore bodies must have had a north-northwest trend, parallel to the more
prominent faults and fracture zones. The Lower and Ladd adits apparently
disclosed little, if any ore, and much of the stoping was carried on between
the Ore Bin adit and the surface.

The small bunches of sulfides exposed in the accessible workings consist
largely of pyrite and chalcopyrite with lesser tremolite, galena, and
sphalerite, but in general the grains are so minute that the microscope is
necessary to distinguish between the individual minerals.

The tenor of the ore mined in the early days is not known, but the
values were probably about the same as at the Kariu. Shipments from the
two veins exposed on the Intermediate level at the far end of the Blacksmith
Shop tunnel are reported to have given fair returns. The average of 37 dry
tons of sulfide ore from the south vein, after sorting 5 per cent of the broken
ore, is reported as 4.2 per cent copper, 0.4 per cent lead, 5.2 per cent zinc,
and 19.25 ounces of silver and 0.005 ounce of gold per ton. The average of
50 dry tons of unsorted ore from the other vein is reported as 3.4 per cent
copper, 0.9 per cent lead, 5.0 per cent zinc, and 15.6 ounces of silver and
0.005 ounce of gold per ton.

Silver Still

The Silver Still lies just east of the Black Hawk (Fig. 2). No mention
is made of the Silver Still in the earlier reports on the district, but the
property may have been known earlier under another name, possibly as the
North Star. Records show that the mine was worked in the twenties and
that in recent years it has been the most active and productive mine in the
district. It shipped some ore in 1923, but most of the development and
production has been since 1929. In the seven years from 1934 to 1940 the
mine shipped 3,628 tons of ore which contained 138,243 ounces of silver,
37.4 ounces of gold, 81,219 pounds of copper, and 109,446 pounds of lead.

The mine has been developed by two adits driven into the steep slope
(Fig. 1), one at about creek level and the other 140 feet vertically above
(Fig. 6). Stopes have been carried from the Upper (Hancock) adit level to
the surface and for a short distance below the level. Little work has been
done on the Lower (Hancock) level. The two adit levels are connected by
raise, and a short intermediate level has been driven from the raise 50 feet
below the upper level.
Fig. 6. Geologic map of underground workings at the Silver Still mine.
Both adits are started in and pass through dioritic rock (the upper adit also through a diabasic dike) into a zone of greatly crushed and extensively fractured rock beyond which the ore bodies lie in highly fractured and altered volcanics. The fracture zone containing the ore bodies trends west-northwest and is more than 60 feet across. It contains irregularly and generally rather sparsely distributed sulfides throughout, but in some places, particularly in and along the more prominent fractures, the sulfides are relatively abundant and form long, narrow bodies of ore. These narrow bodies are nearly vertical, dipping steeply south or north or alternating between one and the other, and may be continuous for several hundreds of feet, one overlapping on the other (Fig. 6). The ore is mostly a replacement of the altered rock. Walls of the ore bodies are not generally sharply defined.

The ore, much of it with fine concentric structures, consists of fine-grained sulfides in a calcite gangue. The more abundant sulfides are pyrite, chalcopyrite, tetrahedrite, sphalerite, and galena; but the ore also contains minor amounts of other sulfides such as marmatite, wurtzite, and enargite and sparse sulfosalts, few of which have been identified.

The ore shipped from 1934 to 1940 contained 36,1 ounces of silver and 0.01 ounce of gold per ton, 1.1 per cent copper, and 1.5 per cent lead. Probably considerable of the ore was oxidized or partly oxidized and hence somewhat enriched in silver, for much of the ore that remains is somewhat higher in copper and lower in silver than that shipped and carries 2 to 3 per cent zinc and up to 3 per cent lead.

Several quartz-tourmaline veins with pyrite in diorite are exposed in the lower Huncook adit (Fig. 6). These seem unworthy of exploration, but the main ore zone on and above the level is entitled to more attention.

Silver Bell

The Silver Bell adjoins the Silver Still on the east (Fig. 2). The mine has been developed by three adits containing more than 2,000 feet of drifts and crosscuts, but all but a part of the workings on the Intermediate adit, reopened by the U. S. Bureau of Mines, are inaccessible.

The Intermediate adit exposes diabase and altered volcanics, both of which are extensively fractured, particularly along or close to their mutual contact (Fig. 7). Satisfactory examination of the ore zone was hindered by heavy timbering and lagging, but bunches of fine-grained sulfides appear here and there in the back and sides of the adit. The distribution of these sulfides suggests rather broad zones of irregularly mineralized rock, trending, northwesterly parallel to the more prominent faults.
Fig. 7. Geologic sketch map of the intermediate adit level Silver Bell mine.
According to Lindgren the ore body in the upper workings was not very
regular nor well-defined and in one place opened up into a big body 40 feet
square composed of oxidized ore, mostly copper sulfate and gypsum. He re-
ports a similar chamber on the Intermediate level, but the ore on the lowest
level was composed entirely of sulfides, less rich than that of the upper
workings.

The sulfide ore seems to be no different from that at either the Maria
or Black Hawk. The ore is chiefly pyritic but contains appreciable amounts
of chalcopyrite and tetrachloride and a little galena and sphalerite.

King

The King lies high on the slope just west of the Silver Still. The
development consists of a 60-foot crosscut and an 100-foot drift, with about
60 feet of exposed stopes probably in part extending to the surface a short
distance above (Fig. 8).

The workings are entirely within much fractured and altered volcanics
and the drift is driven southeast along a vein of general northwest trend
and rather steep northeast dip, in places measuring 65°-75° NE. The vein
is somewhat lenticular and for nearly 50 feet underground is as broad as the
drift is wide. About halfway to the face of the drift the vein pinches
and then breaks up into small stringers (Fig. 8).

The ore shows considerable fine-grained pyrite and some sphalerite,
chalcopyrite and tetrachloride associated with calcite and quartz. Assay
returns to which the writers had access showed less than one per cent copper
and generally less than an ounce of silver per ton.

Sagan

The Sagan mine is on the steep slope facing the North Fork of Bennet
Creek a short distance northwest of the old town of mineral (Figs. 1 and 2).
The mine was among those worked in the early days and probably continued
active until about 1905. It then apparently was idle until 1919 when it
again became an important producer of silver-copper ore. Operations con-
tinued through 1922 after which little if any work was done until the mine
was reopened and supplied by the U. S. Bureau of Mines.
Fig. 8. Geologic map of the King Adit.
Fig. 9. Geologic sketch map of the underground work at the Egan mine.
Fig. 10. Longitudinal section of the Egan mine showing stopes (after U. S. Bureau of Mines) (Projection along line A-B, Figure 9)
The total mine production was not learned. According to Lindgren

the mine is credited with an early day production of 100,000 ounces of silver. From 1903 to 1905 the district produced over 187,000 ounces of silver, but how much of this may have come from the Egan is not known. The Egan was apparently the most productive mine in the district from 1919 to 1922, but production figures were not obtained.

Most of the work at the Egan mine has been confined to four adits and two intermediate levels shown in Figs. 9 and 10. Work not shown includes the 90-foot Carson Discovery adit and the 150-foot Monta adit, the latter not on the Egan lode. Most of the workings, except on the No. 3 level, were accessible in 1945.

The Carson adit penetrates a body of diabase (Fig. 9), but the mineralization is confined entirely to highly altered volcanic rock, apparently of latitic composition. This rock has been extensively fractured, being cut by faults of northeast trend (which have controlled the mineralization) and to lesser extent by faults of northeasterly trend. The main ore zone strikes about N. 60° W., but locally the strike changes to N. 30° W. The dip ranges from 25°-55° NE. The main ore body is as much as 20 feet wide and plunges about 40° NW., at about the same angle as the surface slope (Fig. 10). In places the vein appears to split and locally is bordered by minor, parallel veins.

Ore on upper levels was oxidized but that on lower levels consists of fine-grained sulfides, mostly chalcopyrite, pyrite, and sphalerite, with minor tetrahedrite and galena. Some of the ore mined in the early days was regarded as moderately rich, but that which remains has a rather low copper and silver content.

Boone

The Boone is high on the ridge north of Mineral (Figs. 1 and 2). The mine produced some rich ore in the early days but otherwise little was learned of its early or more recent history. The development consists of three main adit levels connected by raises, (shown in figure 11) and a stope from the intermediate level to the surface (not shown). There are several short adits on the opposite side of the ridge, each of them inaccessible.

The Boone is in the light-colored latitic rock that forms the upper part of the ridge, and as shown on the geologic sketch map of the lower tunnel level (Fig. 11) is along a zone of fractures which trend about N. 50° W.
Fig. 11. Plan and longitudinal section of the Boone mine; geology on lower adit level.
The zone contains a few fractures of more northerly trend, but most of the fractures parallel the long direction of the fracture zone and dip steeply northeast. At the surface the open stopes are aligned N. 30°-60° W., and are inclined about 80° N. The dip of the vein varies between 85° NW. and 72° NE. Most of the ore body and hence most of the stoping is along those parts of the vein where the strike is about N. 30° W., and the dip nearly vertical. The size of the ore body on the middle adit level was not learned. The ore appears to be the fine-grained sulfide type characteristic of the silver-bearing lodes.

Enterprise

The Enterprise is high on the ridge above Mineral a short distance east of the Boone (Fig. 2). The mine produced some rich ore in the early days and was active again during the period from 1918 to 1922, with shipments in 1918, 1919, and 1922. The work is not extensive and consists largely of a 180-foot crosscut with 380 feet of drifts driven northeast and southeast from the crosscut about half way back to the face (Fig. 12). Older work above, mostly cuts and short adits, are only partly accessible.

The mineralization at the Enterprise is much like that in the other mines. The lattic rock has been rather extensively fractured, particularly in a general northwesterly direction, and contains several small veins which strike N. 45°-60° W., and dip 35°-45° NE. (Fig. 12). Individual veins are less than 150 feet long and one appears to overlap another. In places the veins appear to be offset by faults of east-northeasterly trend and northerly dip.

The ore is fine-grained and that piled on the dump contains considerable galena and sphalerite as well as the usually more abundant pyrite and chalcopyrite. Some tetrahedrite also is present.

Liberty

The Liberty is a short distance northeast of the Egan (Fig. 2). Some ore has been stoped, but the production, which was not learned, could not have been large. The workings consist of an adit about 100 feet long driven into the steep slope and small stopes above and below the adit level.

The ore body, which has been drifted on for about 60 feet, abuts against a diabase dike, in which the adit ends. The body strikes about N. 60° W. and dips 60° NE., the mineralization extending across the full width of the adit. The body is cut but not displaced by some steeply dipping fractures, some of which strike about N. 30° E., and others about N. 40° E. The mineralization is apparently similar to that at the Egan.
Fig. 12. Geologic sketch map of the Enterprise mine.
Black Jack

The Black Jack lies in a gulch tributary to Dunnett Creek a short distance southeast of the Silver Bull (Fig. 2). The property has had little, if any production, and has not been extensively developed. The workings consist of a short adit and winze at the outcrop and a longer adit (Fig. 13) on the slope 210 feet below.

As shown in figure 13, the altered volcanics and two bodies of diabase are cut by rather numerous faults of general northwesterly trend and steep southwesterly and northwesterly dip and by some fractures of lesser magnitude, which are lightly mineralized. Most of the faults contain from 1 to 2 feet of gouge, but the major fault, which strikes nearly due east and has been drifted on for nearly 200 feet, contains 5 to 6 feet of gouge. This fault has a dip ranging from 35° to 55° NE. The purpose of the adit apparently was to cut the vein exposed in the upper adit and winze, but the adit is short of its goal. As exposed in the upper workings the vein dips about 40° SW.

Some oxidized ore of low copper and silver content is exposed in the upper adit and a little pyrite and chalcopyrite appear in the winze. In the lower adit several quartz-tourmaline lenses with pyrite occupy fractured rock about 120 feet from the portal, and some pyrite, sphalerite, and chalcopyrite are exposed in the raise at the point where the drift leaves the main crosscut. Other quartz veins from 1 to 3 feet thick carrying pyrite extend across the crosscut about midway between the drift and the face.

Condor (Jessie)

The Condor, which includes the Jessie, is along Dunnett Creek half a mile above the town at an altitude of about 3,600 feet (Figs. 1 and 2). The development includes a number of short adits on almost as many veins, most but not all of which are shown in Figure 14. The main work is the Jessie adit, but the best disclosures are the outcrop and the shorter adits just below the outcrop.

All the veins are in the dioritic rock, which is cut by a number of diabasic dikes. The main vein undercut by the Jessie adit has a northwesterly trend at the outcrop and dips 45° NW., measuring 2 to 3 feet wide. No vein corresponding to this, however, appears in the Jessie adit. Instead there are a number of mineralized fractures crossing the adit, most of them with northwest trend and rather steep southwest, exceptionally northeast dip (Fig. 14). Most of the veins exposed in the short adits on the ridge above strike in an east-northeastly direction and dip 30° to 75° NW. These veins range from a few inches up to about 3 feet thick, exceptionally more.

25
Fig. 13. Geologic sketch map of the lower adit at Black Jack mine.
The vein fillings consist chiefly of coarse-grained pyrite, chalcopyrite, and sphalerite in a gangue of quartz and tourmaline, with minor calcite. Some veins contain as much as 30 inches of massive sulfides, but others are chiefly quartz and tourmaline. Some of the veins are reported to contain appreciable amounts of gold.

Tate

The Tate covers a part of the ridge northeast of the Condor (Jessie) group about a mile east of the old town of Mineral (Figs. 1 and 2). There are a few workings but those present have uncovered about a dozen quartz-tourmaline veins, most of which strike about N, 80° E, and dip 55°-80° NW. The veins are in the dioritic rock and locally are cut by diabasic dikes. The veins range up to 35 feet wide and are composed largely of quartz with some coarse-grained pyrite, chalcopyrite, sphalerite, and tourmaline.

Dennett Creek

The Dennett Creek group adjoins the Tate on the east and covers an area of extensively fractured and mineralized rock at elevations between 5,000 and 5,500 feet (Figs. 1 and 2). The property has been explored by a number of cuts and short adits which have uncovered many generally small veins of east-northeast trend as well as a few of more northerly trend. The veins are rather closely spaced, are considerably faulted, and in places are cut by diabase dikes. They are in the dioritic rock but high on the ridge appear to extend into schistose volcanic rocks. The veins are ordinarily an inch or two thick and rarely exceed 2 feet, but in many places they are so closely spaced as to suggest a stockwork. The mineralization is the quartz-tourmaline type with pyrite, chalcopyrite, and sphalerite.

The relations suggest a large, low-grade deposit, but whether the deposit is large enough or rich enough for large-scale, low-cost operation is not known.

Azurite

The Azurite adjoins the Tate group on the south (Figs. 1 and 2). Little work has been done on the property and consequently there is not much to be seen. One short adit on the Azurite No. 1 claim is driven east-northeast along a 12-inch vein which dips 55° NW. The vein contains quartz, pyrite, chalcopyrite and sphalerite. It as well as a vein on the Azurite No. 2 is in the dioritic rock. This second vein is about 18 inches thick over a length of 10 feet, but surface float may be traced for an additional hundred feet. It contains a malachite-stained, quartz-tourmaline filling.
Fig. 14. Geologic map of workings on the Condor (Jessie) group.
Fig. 14. Geologic map of workings on the Cando (Jessie) group.