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Geology and Mines of the Upper Blackfoot Valley, Montana

Thomas K. Shea

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GEOLOGY AND MINES
OF THE,
UPPER BLACKFOOT VALLEY,
MONTANA

By

Thomas K. Shea

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BUTTE

A Thesis
Submitted to the Department of Geology
in Partial Fulfillment of the Requirements
for the Degree of Bachelor of Science
in Geological Engineering

MONTANA SCHOOL OF MINES
Butte, Montana
June 6, 1947
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The author wishes to thank the mine managers and residents of the area for their assistance in the gathering of information. Last, but not least, the author is indebted to Judson Whitman and Kohler Stout, fellow students who accompanied the author on his visits through the area described in the report.
INTRODUCTION

PURPOSE

The purchase and continued operation of the Mike Horse mine in the Heddleston district, by the American Smelting and Re-finining Company, gives the Blackfoot Valley a renewed promise of a prosperous future in its role as a mining district (1). In the past, large amounts of placer gold were recovered from the gulches of the area, however, because of the transportation facilities, only the upper portions of a few lodes were exploited by the early miners. Hoover states that with decreasing world production, metal prices will be raised to the point where profits in mining will be greater, thus encouraging prospecting (2); and with modern transportation, better roads, and the increasing shortage of metals, the area under consideration should be opened to further development. The Mike Horse mine is the first mine in the area to receive the participating attention of a large company in the search for new ore bodies.

1. Mining World, Mine development and directory number, 1946.
In this report, the author describes the general geology, mining of the past, and the present mining of the region. The geology given here is taken from the writings of Clapp, Deiss, Pardee, and others who have worked in this area or in adjacent areas. The information on mining was gathered by the author during the winter of 1946-1947.

PREVIOUS WORK

Many geologists of the U. S. Geological Survey have studied the rock formations and mining districts of northwestern Montana. In 1921 Montana Bureau of Mines and Geology started a geologic map of western Montana, and although soon completed in manuscript form, it was not published in printed form until 1944. The near-by mining districts of Marysville, Ophir, Helena and Garnet, have been studied in much detail but the Blackfoot region has received very little attention by geologists. In 1930, Clapp and Deiss (3) carried a geologic section across western Montana from Missoula to Helena through the Blackfoot Valley. The only published report on the lode mines in the area is that of Pardee (4) of the U. S. Geological Survey. Placer properties in the area were described by Dingman (5,6)

in several of his reports. The work of other mining geologists in the region, including the work of the geologists of the Anaconda Copper Mining Company in the timberlands of this area, has not been published.

LOCATION

The area being considered in this report is shown in the index map given as Fig. 1. It includes that part of Powell county and Lewis and Clark county in townships 6 to 12 west and ranges 11 to 16 north.

The western portion of the area is reached best from Avon, a town on highway U. S. 10N., by automobile over a well graded county road. The eastern part of the Blackfoot Valley can be reached easily from Helena over the Helena-Lincoln road. Although Plate 2 shows many roads crossing the area, most of them are not open except during the summer months. The Helmville-Lincoln road, running east and west through the area, is often closed by severe storms during the winter months.
The region is divided by drainage into two parts, with the dividing line formed by the Ogden-Dalton-Granite Butte mountain belt (Plate 2). The area is mountainous with dissecting valleys 1,000 to 3,000 feet deep. This region belongs to the Rocky Mountain Cordillers of North America, a terminology given by Daly (7).

The northern portion includes the south end of the Lewis and Clark range, and is in general more mountainous than the southern part of the area. Roughly paralleling the Mission, Swan and Flathead ranges, the Lewis and Clark range trends North 30 West and has a general elevation of 6,000 to 7,000 feet above sea level. Local glaciation has developed deep valleys with flat bottoms and steep sides. The area to the north of the Blackfoot River contains numerous lakes in the basins of old cirques. Topography of this region is that of Alpine topography, and it is heavily forested.

The south part of the area includes the Avon Valley between the Ogden-Dalton mountains and the Garnet range. The mountains slope gently into the wide flat valley of the Avon, which is cultivated from place to place. This valley is an extension of the ancient Swan Valley now divided by a drift north of Ovando (8).

Looking down the Blackfoot Valley from Flesher Pass on the Lincoln-Helena highway.
DRAINAGE

The north section mentioned above is drained by the head waters of Blackfoot River and its tributaries. Nevada Creek drains that portion of the Avon Valley considered in this report. It empties into Blackfoot River near the little town of Helmville in the western portion of the area. The head waters of both streams originate near the top of the Continental Divide and run westward into Helmville Valley, which is also known as Nevada Valley.

DESCRIPTIVE GEOLOGY

The mountains are composed of an extraordinarily thick group of sediments, known as the Belt series of the Algonkian system (9), upper Proterozoic in age. No formations of Paleozoic or Mesozoic eras occur in the area, but they are found on the southern slope of the Garnet range a few miles southwestward. Igneous bodies intruded the Beltian rocks during or following the uplift of the present mountains. Thick beds of sand, gravel, and clay were deposited in Tertiary and Quaternary lakes caused by uplift and glaciers.

SEDIMENTARY ROCKS

BELTS ROCKS (ALGONKIAN)

Ravalli Group

This group of clastic rocks forms the lowest division of the

Belt series exposed in the area. It has been subdivided into the Appekunny and Grinnel formations by Clapp.

**Appekunny formation**: This formation, underlying the Grinnel, is essentially argillite interbedded with quartzite conglomerate, and minor beds of argillaceous limestone. Its color ranges from green and greenish gray to brown with some dull red, white and purplish beds. The argillaceous members are thin-bedded to thick bedded; the conglomerate is massive. Outcrops occur in the canyon where the North Fork of Blackfoot River enters Kleinschmidt Flat; again on Mineral Hill and Dalton Mountain; and in the lower part of Arrastre Creek and Stonewall Creek canyons. In these exposures the Appekunny is separated from the overlying Grinnel formation by a diorite sill which is believed by Clapp and Deiss to be a single unit extended across a large area (10).

**Grinnel formation**: This formation is composed chiefly of red argillites and white to green quartzites. Its texture, colors, and bedding are highly variable. Ripple marks, mud cracks, and current marks are abundant. The Grinnel formation is exposed overlying the Appekunny in the above mentioned canyons.

**Siyeh or Wallace Group**

Clapp and Deiss assigned the thick impure limestone above the Grinnel to the Siyeh group (11). Their findings were correlated

---

with the work of Calkins (12, 13) and Walcott (14, 15).

Newland (Lower Siyeh): The impure argillitic, dolomitic, and sideritic limestone and the calcareous beds found above the Grinnel formation along Stonewall Creek, Arrastre Creek, and the North Fork of Blackfoot River, are correlated with the Newland limestone of the Belt Mountains. An exposure of the formation occurs one mile west of Landers Fork for three miles along the Lincoln-Helena road.

Spokane formation: The middle part of the Siyeh group found in this area is similar to the Spokane formation of other Belt facies. Outcrops of red and green clastic sediments may be found in the northeast section of the region. In many localities it is intruded by igneous rocks.

Helena formation (Upper Siyeh): The impure limestone beds of the Upper Siyeh are correlated with the Helena limestone in the Prickly Pear Creek section. The formation consists of argillaceous and arenaceous dolomites and magnesian limestone in thin beds but thick groups of similar strata. Interbedded with the main mass of strata is a greenish-white quartzite. The formation is characterized by ripple marks, mud cracks,

channel fillings, and mud breccias; it is exposed along the banks of eastern Nevada Creek and in the area north of Blackfoot River.

Missoula Group

The group is composed mainly of argillites, quartzites, and sandstones, with minor beds of impure limestone, calcareous shale and conglomerates. Characteristic patterns of ripple marks, mud cracks, and salt casts are present. This group, the uppermost of the Belt series, is represented in the area by exposures along the northern boundary, and in the southeastern corner of the area (Plate 1).

TERTIARY

Lake beds: Thick deposits of clay, sand, gravel, and some lignite underlie the glacial drift and alluvium of the valley floors. Erosion has cut into small areas in the region. Artesian wells over 300 feet deep, near Helmville, are yielding water from these Tertiary lake beds.

QUATERNARY

Glacial moraines of several different periods cover the bottoms of Blackfoot Valley, the gulches around Lincoln and the north edge of the Avon Valley. A reddish clayey till containing weathered boulders of quartzite, red and green argillite, and other rocks is exposed along the south side of Blackfoot Valley near Lincoln, and on the hills east of
Sauerkraut Gulch. Pardee gives the age of these deposits as Pre-Wisconsin, distinguished from other moraines by the amount of weathering (16). Younger moraines from ridges several hundred feet high are found east of Lincoln near Flesher. These deposits are unweathered, and are probably the moraines of large valley glaciers of Wisconsin age. In the area around Stonewall Mountain, moraines of recent glaciation form dams across the mouths of the cirques, thus making the basins of the present lakes. Mixed with the glacial drift are the deposits of Lake Missoula, described under Historical Geology.

**IGNEOUS ROCKS**

**GABBROIDAL ROCKS**

Gabbro, diorite and their related varieties form sill, dikes, and smaller irregular stocks throughout the region being described. Only the larger igneous bodies are shown on Plate 1. These are the oldest of the igneous rocks, and it may be impossible to distinguish one from another in age. Clapp (17) found the dikes to be fewer in number than the sills and stocks. The stocks rarely measure over a mile in diameter. The majority of these gabbro-diorite bodies are associated with faults, but some were folded with the enclosing Beltian rocks and cut by the thrust faults, and they may be Algonkian

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in age. The large dike in the Hedleston district is described by Pardee (18) as ranging from a diorite composed chiefly of andesite and hornblende to a gabbro of labradiorite and augite composition. Similar dikes occur in the Upper Cretaceous along the Little Blackfoot River below Avon.

GRANITIC ROCKS

The Granitic rocks form stocks varying in composition from quartz-diorite to granodiorite and quartz monzonite. Quartz monzonite with marginal facies of monzonite and diorite in the form of stocks are most common. The Boulder batholith, a term first used by Weed (19), extends north to Mullen Pass, a few miles southeast of the described area. The Marysville stock, which is similar to those of this area, is described by Barrell (20) as a quartz diorite similar to the Butte quartz monzonite. Barrell (20) and Knopf (21) apparently regard the Marysville stock as contemporaneous with the Boulder batholith at Mullen Pass. Agreeing, Billingsley (22) believes that all granitic rocks in the areas adjacent to the batholith are connected at depth with the batholith.

## Stratigraphic Column

**by**

C. H. Clapp*

<table>
<thead>
<tr>
<th>Geologic Age</th>
<th>Formation</th>
<th>Thickness</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recent</strong></td>
<td>Alluvium</td>
<td></td>
<td>Flood-plain, delta, alluvial-fan, and talus-slope deposits of gravel, sand, and clay.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Later drift</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bench and valley deposits</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wisconsin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Older drift</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unconformity</strong></td>
<td><strong>Oligocene and Miocene, and Unconformity-</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>&quot;Lake&quot; beds</strong></td>
<td></td>
<td>1,000</td>
<td>Clay, sand, gravel, marl, volcanic tuff, and some lignite.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td><strong>Missoula group</strong></td>
<td></td>
<td>10,000</td>
<td>Red, purple, green, and gray argillites, quartzites, and sandstones; minor impure carbonate beds and limestone.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to 18,000</td>
<td></td>
</tr>
<tr>
<td><strong>Helena</strong></td>
<td></td>
<td>2,000</td>
<td>Thin bedded, siliceous, argillaceous, and sideritic limestone, and calcareous argillite; minor magnesian limestone. All weathering buff.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to 6,000</td>
<td></td>
</tr>
<tr>
<td><strong>Newland</strong></td>
<td></td>
<td>500</td>
<td>Red and green argillites and quartzites; lower portion green-gray and dolomitic and sideritic shale.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to 6,000</td>
<td></td>
</tr>
<tr>
<td><strong>Grinnell</strong></td>
<td></td>
<td>2,000</td>
<td>Red with some green argillite, sandstone, and sandy quartzite.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,500</td>
<td></td>
</tr>
<tr>
<td><strong>Appekunny</strong></td>
<td></td>
<td>3,500</td>
<td>Green-gray to light to dark argillitic and sandy quartzite, quartzitic argillite; some massive white quartzite.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to 10,000</td>
<td></td>
</tr>
</tbody>
</table>
## Igneous Rocks

<table>
<thead>
<tr>
<th>Geologic Age</th>
<th>Formation</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary</td>
<td>Volcanics</td>
<td>Basalt, andesite, dacite, latite, and rhyolite.</td>
</tr>
<tr>
<td>CENOZOIC</td>
<td>Lower Eocene, may include some Algonkian sills and dikes</td>
<td>Chiefly diorite and gabbro-diorite.</td>
</tr>
<tr>
<td></td>
<td>Batholiths and stocks</td>
<td>Chiefly quartz monzonite.</td>
</tr>
<tr>
<td>MESOZOIC</td>
<td>Upper Cretaceous Volcanics</td>
<td>Chiefly andesite.</td>
</tr>
</tbody>
</table>

If this is true, the stocks of granodiorite and diorite in the Blackfoot region are merely basic facies on the border of the quartz-monzonite mass.

**VOLCANIC ROCKS**

Fine-grained andesite flows and breccias, colored in different shades of purple and green, cover the Belt rocks of Seven-up Pete Gulch; in the Heddleston district a dike of rhyolite cuts a diorite sill, and in turn is cut by a trachyte porphyry. Extensive volcanic flows cover the northern slope of the Garnet range along the Avon valley.

**STRUCTURAL GEOLOGY**

**SEDIMENTARY STRUCTURES**

**RIPPLE MARKS**

Ripple marks, caused by shallow water free from tidal currents, are abundant in Appekunny and Grinnel basal quartzites and also in certain beds of the Spokane and Helena formations. Waves seem to have produced the symmetrical marks rather than current although ripple marks of the Grinnel and Spokane are believed by Fenton (23) to be of current origin.

**MUD CRACKS AND MUD FILLINGS**

Thin layers of argillite formed mud cracks on drying, and

in places were filled with calcite. Argillaceous beds of the Appekunny, Newland, and Spokane formations show these structures.

MUD BALLS, PEBBLES, SANDS, AND BRECCIAS

These mud lumps range from round to subangular up to 20 mm. in diameter. The mud lumps show concentric lamination produced by waves or currents rolling mud on beaches into balls. The Grinnel and Spokane formations show these structures.

DIASTROPHORIC STRUCTURES

FOLDS

The pre-Tertiary rocks of the area were deposited in the Algonkian geosyncline which was folded into a large synclinorium whose axis trends North 25 West. The present Continental Divide closely follows the axis of the synclinorium. The minor folds of the region appear to be drag folds produced mainly by faulting. In adjacent areas where post-Algonkian rocks are found, synclines and anticlines are more apparent than in this area. The structures of the region are much more simple than those in southwestern Montana. Sedimentary structures, such as ripple marks and mud cracks, were not greatly distorted during the periods of folding and faulting. Forces acting in a lateral direction, parallel to the Earth's surface (24), folded the geosyncline first into simple folds, and then into more

complicated overturned folds under continued lateral compression. The parallel mountain ranges (Mission, Swan, Flathead, Lewis, and Lewis and Clark) are folded and faulted mountains produced by such lateral stresses. This deformation is believed to be a part of Laramide orogeny.

FAULTS

During the final stages in the deformation of a geosyncline rupture occurs, and the hanging wall of overturned folds slides over the footwall, thus producing a low-angle thrust fault (25). Separating each of the above mentioned mountain ranges is a low angle thrust fault, the Lewis and Clark thrust fault being the best known of these. It appears that the lower fault on Plate 1 as mapped by Clapp (26) is a continuation of the Mission thrust fault, and the fault along the South Fork of Blackfoot River is the south end of the Swan thrust fault. The north trending faults in the eastern section of the area seem to be closely associated with the Lewis and Clark thrust. The transverse faults shown on Plate 1 are a probable result of the rock masses in the folds shearing during settling. A few of these developed during the folding, and were cut by the thrusting of the folds, however, the majority developed


after the release or dying out of the lateral stresses, and they cut the thrust faults. Crustal movements are still active in the area as verified by recent earthquakes.

METAMORPHIC STRUCTURES

The thick sediments originally composed of clays, sands, and marls of Algonkian time were metamorphosed into argillites, quartzites, and impure marbles. The processes of metamorphism were slow and gentle as evidenced by the presence of sedimentary structures with little or no distortion. The contact effects of intruding igneous bodies upon sedimentary rocks was found by Barrell (27) to be slight.

GEOLOGIC HISTORY

ALGONKIAN

The thick sediments of the Belt series were deposited in the shallow and undulating seas of late Proterozoic time. These seas were withdrawn during the Grand Canyon revolution, and the land mass slightly tilted. There is a conflict of opinion among the geologists who consider the Belt series, or parts of it, to be non-marine. Barrell (28) assigned the dolomites and limestones to marine sediments, but is not definite about the quartzites. The Spokane is believed by Calkins (29) to be non-marine.

flood plain. The Fentons (30) found brachiopods in the Newland and Helena beds and, with minor reservations, believe the Belt rocks to be marine.

The wide-spread occurrence of oscillation ripple marks in certain quartzites indicates a shallow sea free from currents. Mud cracks are best developed in localities subjected to alternating submergence and emergence and a dry, warm climate (31). They are characteristic of playas, flood plains, and tidal flats; essentially continental in origin; and always indicate that the water in which the mud or clay accumulated was relatively shallow (32). Carbonate beds are thicker in the eastern exposures of the Belt rocks than in the western exposures, indicating that the source of sediments was to the west, but there is no definite evidence of shore lines or intervening uplifts. Apparently the pre-Cambrian seas were shallow and periodically undulating, developing wave ripple marks in the sands and depositing thin layers of mud. The mud layers were allowed to crack and dry and harden during a period when the seas were low.

**PALEOZOIC AND MESOZOIC**

Sediments of these eras are absent in the area, but they occur beyond the eastern, northern, and southern boundaries.

It seems likely that Paleozoic and Mesozoic sediments were deposited over all of this region, only to be eroded away during and following the uplift of the present mountains. No intense folding or faulting is believed to have occurred during Paleozoic or early Mesozoic times, but during the late Cretaceous period Laramide orogeny deformed the entire region. In early Tertiary times erosion cut down nearly to the present land surface.

**CENOZOIC**

**TERTIARY**

In early times when western Montana was drained by southward-flowing streams tributary to Snake River, extrusions of large lava flows in southern Idaho dammed the south-flowing drainage, backing up the water, and forming large lakes in western Montana (33). During this time the Tertiary lake beds were deposited. The water later spilled over the mountain passes of western Montana and Idaho, cutting deep gorges, and diverting the drainage of northwestern Montana to the west into Columbia River. Excepting Flathead Lake, the lakes then became extinct.

**QUATERNARY**

Quaternary glacial till and alluvium now cover much of the lake beds. During this era there were several periods of


-16-
glaciation, the degree of weathering that the moraines show distinguishing the difference in age. Alden (34) states that the older drifts are deposits of large valley glaciers, and that the younger moraines are deposits of large ice sheets of Wisconsin age. Mixed with the glacial till are the lake beds of Lake Missoula which were formed when glacial ice dammed the north- and northwest-flowing rivers. An arm of the lake extended up the Blackfoot basin to Helmville with the shore line following close to the 4200-foot contour (35).

Most of the igneous activity followed the uplift of the Cordilleran geosyncline. Knopf (36), Pardee (37), Clapp (38), and other writers, are agreed that the time of the granitic intrusions was late Cretaceous or early Tertiary. The succession of major geologic events is listed below as it affected the region.

1. Folding and uplift..................Late Cretaceous
2. Overthrusting.......................Early Eocene
3. Intrusion of granitic rocks..........Eocene
4. Removal of Paleozoic and Mesozoic rocks by erosion...........Late Eocene

1. The broad flat valley of the Blackfoot River near Lincoln.
2. The Lincoln-Helena road cutting through a glacial deposit near Flesher.
3. The rolling hill in the foreground is a glacier moraine in the center of the Blackfoot Valley near Flesher.
4. The large foot hill is another moraine deposit near Flesher.
5. Extrusion of Andesite flows........Oligocene
6. Extrusions of rhyolite........Miocene
7. Tertiary lake beds.................Miocene
8. Glaciation of mountains........Pliocene and Pleistocene

ORE DEPOSITS

Metal-bearing lodes and placer deposits occur throughout the area. Although formerly very productive, the placer deposits have become depleted to the extent that they are of small economic importance. The gold of the placers apparently came from eroded lodes deposits near the heads of the various gulches.

The lodes deposits belong to either of two groups, an older group or a younger group. As indicated by their proximity and other relations to the intrusive granitic rocks, the older lodes were probably derived from the same magma that produced that rock. The younger group is similar in mineralogy and other features to the lodes known elsewhere to be Oligocene (39). These lodes may possibly be related to buried intrusives or to a later dike rock such as the Trachyte dike in the Heddleston district.

The older group of ore bodies includes filled fissures, filled breccias, and shear zones. The younger group includes the same types of bodies, and in addition replacement deposits along the fractures.

The lode deposits contain principally gold, silver, and lead. Zinc is quite common in the ore bodies of the eastern Heddleston dist-

strict. In a few veins, copper minerals are found, and where copper is found, the percentages of silver are very high. The gangue minerals include quartz, pyrite, calite, ankerite, and sericite. In the lower grade gold mines, the amount of vein quartz is very high. In the lead mines of Heddleston, the principal gangue minerals are sericite and ankerite, which are described by Pardee as a "gray gangue". The veins are associated with various types of igneous rocks. In the western part of the area, the gold-lead bearing veins occur in a granitic stock quite similar in composition to the Butte monzonite, and in a diorite sill. In the Heddleston district, veins occur in the diorite, trachyte, and rhyolite. Most of the lodes are found along the boundaries of the igneous bodies, and occur both in the igneous masses and in the rocks of the Belt series.

PRODUCTION

Accurate information on production figures for the various mines of the area are impossible to obtain, because so many of the mines are operated by lessees who only stay for a short period. The residents of the area often never know the names of the lessees. The only mine yet to reach any importance as a producer is the Mike Horse mine in the Heddleston district, and even this mine was almost unknown until 1940. It is probable that other small mines will become known producers in the near future. The production of the mining properties has been intermittent with a general increase during periods of low wages and prices. The lack of good roads has retarded real prospecting and development of mines in this area.
Production Tables

The following production figures were taken from the Mineral Year Book (40).

<table>
<thead>
<tr>
<th>Year</th>
<th>Mines</th>
<th>Gold</th>
<th>Silver</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lod. Pl.</td>
<td>ozs.</td>
<td>ozs.</td>
<td>lbs.</td>
<td>lbs.</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>1934</td>
<td>Heddleston</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>7,919</td>
<td>601</td>
</tr>
<tr>
<td></td>
<td>Helmville</td>
<td>1</td>
<td>58.34</td>
<td></td>
<td></td>
<td></td>
<td>1,212</td>
</tr>
<tr>
<td></td>
<td>Washington</td>
<td>7</td>
<td>492.12</td>
<td></td>
<td></td>
<td></td>
<td>10,058</td>
</tr>
<tr>
<td>1935</td>
<td>Heddleston</td>
<td>1</td>
<td>22.06</td>
<td>464</td>
<td>11,865</td>
<td>1,518</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helmville</td>
<td>185.18</td>
<td>116</td>
<td>162</td>
<td>6,561</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Washington</td>
<td>881.66</td>
<td>88</td>
<td>30,864</td>
<td>3,059</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jefferson</td>
<td>85.55</td>
<td>79</td>
<td>432</td>
<td>3,059</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remarks:</td>
<td>The Shamrock mine of the Shamrock Mines, Ltd., was operating in American gulch.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1936-1937</td>
<td>Helmville</td>
<td>2</td>
<td>346.20</td>
<td>77</td>
<td>12,172</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Washington</td>
<td>1</td>
<td>1,571.20</td>
<td>177</td>
<td>15,129</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remarks:</td>
<td>The El Dorado Gold Placer Mines Company produced most of the gold in Washington gulch from May to October, 1937.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1938</td>
<td>Lincoln</td>
<td>2</td>
<td>195</td>
<td>23</td>
<td>6,840</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helmville</td>
<td>2</td>
<td>101</td>
<td>80</td>
<td>3,604</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Washington</td>
<td>2</td>
<td>206</td>
<td>133</td>
<td>14,215</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remarks:</td>
<td>Silver Bell in the Poorman district was operating. The Hill Top mine and the Sweepstake mines in the Helmville district were operating. The Grey mine in Washington gulch was operated by the Great States Gold Mining Company. The Blue Cloud Mining Co. worked the Bloon and Old Billy Williams placers in the Lincoln district. Production decreased in Stonewall gulch.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1939</td>
<td>Heddleston</td>
<td>1</td>
<td>280</td>
<td>12,394</td>
<td>8,481</td>
<td>14,596</td>
<td>19,781</td>
</tr>
<tr>
<td></td>
<td>Lincoln</td>
<td>1</td>
<td>268</td>
<td>50</td>
<td>183</td>
<td>9,433</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helmville</td>
<td>3</td>
<td>230</td>
<td>445</td>
<td>135</td>
<td>8,380</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Washington</td>
<td>10</td>
<td>549</td>
<td>131</td>
<td>19,411</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jefferson</td>
<td>1</td>
<td>13</td>
<td>9</td>
<td>461</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remarks:</td>
<td>Lincoln Metals Co. shipped 40 tons of gold ore from Blackfoot mine in Lincoln gulch for testing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Remarks: Stonewall Gold Mining Co. and Blue Cloud Mining Co. operated dredges in the Lincoln district. Hild Gold Mining Co. worked the Blackfoot Gold mine on Odgen Mountain. The Hill Top mine on Odgen was worked also. The Washington Gulch Leasing Co. operated a dredge on the El Dorado placer. The Prize mine in the Poorman district was opened by the Granite Butte Mines Co. Lessees reworked the dump at the Anaconda property in the Heddleston district. The Wiggins property in Jefferson gulch was open for a short time.

<table>
<thead>
<tr>
<th>Mines</th>
<th>Gold</th>
<th>Silver</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lod. Pl.</td>
<td>ozs.</td>
<td>ozs.</td>
<td>lbs.</td>
<td>lbs.</td>
<td>$</td>
</tr>
<tr>
<td>Heddleston</td>
<td>5</td>
<td>135</td>
<td>5,438</td>
<td>2,398</td>
<td>49,340</td>
<td>13,830</td>
</tr>
<tr>
<td>Lincoln</td>
<td>3</td>
<td>7</td>
<td>68</td>
<td>149</td>
<td>1,700</td>
<td>2,585</td>
</tr>
<tr>
<td>Helmville</td>
<td>2</td>
<td>1</td>
<td>15</td>
<td>31</td>
<td>840</td>
<td>517</td>
</tr>
<tr>
<td>Washington</td>
<td>1</td>
<td>8</td>
<td>691</td>
<td>121</td>
<td></td>
<td>24,313</td>
</tr>
<tr>
<td>Jefferson</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: In the Heddleston district, 1,520 tons of gold ore and old tailings were cyanided on the Andrew Brown property, Anaconda mine. A few cars of crude ore were shipped from the Mike Horse mine. The Gold Dollar, Lincoln and Mazima Mines Co. operated placers in the McClellan and Park gulches. Usina a dry-land dredge, the McKenzi Placer Co. worked the Toole Patent in Jefferson gulch.

| 1941               |        |         |        |       |       |       |
| Heddleston         | 4      | 78      | 65,482 | 123,700| 1,433,000| 1,096,000| 256,273|
| Lincoln            | 3      | 8       | 112    | 52    |       |       | 3,957  |
| Helmville          | 4      | 3       | 502    | 124   | 100   |       | 17,753 |
| Washington         | 1      | 12      | 94     | 24    | 700   |       | 3,342  |
| Jefferson          | 1      | 19      |        |       |       |       | 665    |

Remarks: The Mike Horse Mining and Milling Co. operated with a 150 ton flotation mill. The Silver Bell mine was open. The Western Montana Gold Mining Co. worked several mines on Odgen Mountain and operated a 30 ton mill.

| 1942               |        |         |        |       |       |       |
| Heddleston         | 2      | 146     | 197,259| 683,800| 4,579,600| 2,532,000| 770,432|
| Lincoln            | 1      | 136     | 38     | 300   |       | 4,807  |
| Helmville          | 1      | 3       | 362    | 159   | 300   | 12,803 |
| Finn               | 4      | 102     | 14     |       |       | 3,580  |

Remarks: The Mike Horse Mining and Milling Co. increased its milling capacity to 200 tons a day and doubled its production of 1941. The Swansea Mines Inc. treated 1,500 tons of gold-silver ore from the Carbonate mine in its 70 ton mill. The Missoula-Lincoln Metals Co. operated a dry-land dredge on the Blue Bird placers in Lincoln gulch during June and July.
<table>
<thead>
<tr>
<th>Year</th>
<th>Mines</th>
<th>Gold</th>
<th>Silver</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943</td>
<td>Heddleston</td>
<td>1</td>
<td>130</td>
<td>198,104</td>
<td>732,800</td>
<td>4,700,200</td>
<td>1,905,000</td>
</tr>
<tr>
<td></td>
<td>Helmville</td>
<td>1</td>
<td>8</td>
<td>66</td>
<td>2,200</td>
<td>1,905,000</td>
<td>798,943</td>
</tr>
</tbody>
</table>

Remarks: The Mike Horse mine in the Heddleston district treated 57,800 tons of lead-zinc ore. The Miller mine on Mar-cum Hill was open for a short period. It shipped 25 tons of test ore.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mines</th>
<th>Gold</th>
<th>Silver</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1944</td>
<td>Heddleston</td>
<td>2</td>
<td>194</td>
<td>164,620</td>
<td>505,400</td>
<td>4,872,100</td>
<td>3,057,500</td>
</tr>
<tr>
<td></td>
<td>Finn</td>
<td>1</td>
<td>2</td>
<td>505,400</td>
<td>4,872,100</td>
<td>3,057,500</td>
<td>930,400</td>
</tr>
<tr>
<td></td>
<td>Jefferson</td>
<td>1</td>
<td>3</td>
<td>505,400</td>
<td>4,872,100</td>
<td>3,057,500</td>
<td>930,400</td>
</tr>
</tbody>
</table>

Remarks: The Mike Horse Mining & Milling Co. increased its pro-duction 16% over 1943. The Carbonate mine under lease by the Swansea Mines, Inc. shipped 197 tons of lead concentrates. The mine was opened in August and 2,713 tons of crude ore was produced.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mines</th>
<th>Gold</th>
<th>Silver</th>
<th>Copper</th>
<th>Lead</th>
<th>Zinc</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>Heddleston</td>
<td>2</td>
<td>109</td>
<td>147,330</td>
<td>382,200</td>
<td>6,350,500</td>
<td>3,755,800</td>
</tr>
<tr>
<td></td>
<td>Lincoln</td>
<td>2</td>
<td>6</td>
<td>382,200</td>
<td>6,350,500</td>
<td>3,755,800</td>
<td>1,138,240</td>
</tr>
<tr>
<td></td>
<td>Helmville</td>
<td>1</td>
<td>10</td>
<td>6,350,500</td>
<td>3,755,800</td>
<td>1,138,240</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>Finn</td>
<td>1</td>
<td>30</td>
<td>6,350,500</td>
<td>3,755,800</td>
<td>1,138,240</td>
<td>350</td>
</tr>
</tbody>
</table>

Remarks: The Mike Horse property was purchased by the American Smelting and Refining Co. in July. The mill was in-creased to 250 ton capacity. R. W. Cumb and Dan Piper operated a washing plant in Madison gulch from August to October. Swansea Mines Inc. produced 2,500 tons of lead-zinc ore and shipped 231 tons of concentrates.
The placer ground was first worked about 1865, and a moderate amount of gold was recovered. Placer mining declined after 1875. The first dredge was installed in the area near Lincoln in 1931. Other dry-land dredges were operating in Washington gulch and elsewhere during the last decade, and besides gold, tungsten was also recovered in Lincoln gulch. Although the placer ground is largely exhausted, miners working with wheelbarrow and sluice box, or with pan, are able to produce $4 to $5 in gold a day from the old tailings and stream banks. Ted Kieley of Finn states that in times of depressions there are many miners active in the gulches around Finn (41).

MINING DISTRICTS

HEDDLESTON DISTRICT

LOCATION

The district is about 55 miles northwest of Helena by the Helena-Lincoln highway which passes over the Continental Divide at Flesher Pass. Silver, a station on the Great Northern Railway, is the closest shipping point. It is 40 miles from the Mike Horse mine. There also is another road up from Lincoln along the Blackfoot River. The district lies along the steep west slope of the Continental Divide. The head waters of the Blackfoot River and its tributaries, Pass Creek and Shoue Creek from the north and Mike Horse Creek from the south, drain the area.

41. Kieley, Ted, Personal communication.

-20-
GEOLOGY

The Spokane formations are well exposed over the area, but igneous dikes intruded the Beltain rocks. The oldest of the intrusive rocks is a dark greenish-gray crystalline rock that shows dark hornblend and other ferromagnesian mineral in a feldspathic groundmass. This sill, 500 feet thick, is called a diorite by Pardee, but the managers of the Mike Horse refer to it as a gabbro. The gabbro-diorite sill is cut by several trachyte porphyry dikes ranging from a few feet to over a hundred feet in width. Both the older sill and the younger dikes trend to the northwest. At the Calliope mine a rhyolite dike intrudes both the trachyte and gabbro-diorite. Only the quartz grains remain unaltered in the rhyolite. The other phenocrysts and groundmass minerals have changed to sericite.

ORE DEPOSITS

The ore deposits of the district are mostly filled breccias. All the veins trend in a northwesterly direction and dip steeply. With the exception of the deposits in the Calliope mine, where the ore occurs in cylindrical bodies 6 to 8 feet in diameter, the ore bodies are tabular in shape. The valuable ore is found in shoots along the strike of the vein. Post-mineral movement has crushed the ore bodies, but veins were not deformed to any appreciable extent. The ore minerals are principally lead, gold, silver, and zinc with minor amounts of copper. Where the copper minerals are found, the silver content increases.
Mike Horse

The main haulage adit is about a mile up Mike Horse Creek from the Blackfoot River on the south side of the creek. Discovered in 1898, the mine produced intermittently until 1940 when the Mike Horse Mining and Milling Company started operating the mine. The production was never large before 1941, but since then the mine has become one of the largest lead producers in Montana.

In July 1945, the mine was purchased by the American Smelting and Refining Company, and is now operated by the Federal Mining and Refining Company, a subsidiary of American Smelting and Refining Company. The new owners have done considerable development work to increase the production. A winze in the haulage adit at the 300 foot level is being extended downward below the 600 foot level. Wilbur Criswell, an engineer of the former Mike Horse Mining and Milling Company, states that there is a large reserve of ore in the mine (42). A 250-ton flotation mill, now running at full capacity, is operated near the mine entrance. The total number of men employed in April, 1947, was 235, of which 125 were miners.

The geology of the mine consists of Belt rocks intruded by a gabbro sill which is in turn cut by a trachyte porphyry dike. Mineralizing solutions penetrated the above rocks, and post-mineral movement crushed the ore bodies without causing much cross faulting. The valuable ore is found in shoots, and because of this, consider-

42. Criswell, Wilbur, personal communication.
able development work must be done ahead of the stoping operations. The wall rock apparently had very little influence on the ore deposition (43). The ore shoots in the gabbro sill do not differ in size or mineralogy from those in the trachyte or the argillite which constitutes the country rock.

The important deposits occur in two separate veins. The Mike Horse vein strikes N. 65-70° W. and dips about 80° to the south, and the other vein known as Little Nell, trends N. 55° W., but dips steeply in the opposite direction from the Mike Horse vein. The Little Nell vein was never developed to any extent until the new owners took over the mine. Mr. A. Haeseler, superintendent of the property, reports that heavy timber is required to hold the walls.

In the ore shoots the important ore minerals are galena, sphalerite, silver, and gold, and some bornite, chalcopyrite, and tetrahedrite are present. Where copper occurs the ratio is \( \frac{4}{3} \) ounces of silver to \( \frac{1}{3} \) copper. In the lead ore, the ratio is \( \frac{1}{4} \) ounces of silver to \( \frac{1}{3} \) lead. The gold averages about 0.5 ounces to the ton of ore mined. All the ore being mined at the present time is primary ore, and Haeseler believes that the oxidized ore must be very close to the surface, and that the mining operations have not as yet reached it (44). An abundant amount of pyrite is found both in the ore and disseminated in the wall rock. Other gangue minerals are quartz, sericite, and ankerite.

43. Haeseler, A., personal communication.
44. Haeseler, A., personal communication.
Plate 5

Mike Horse mill

Mike Horse haulage adit
Carbonate

The Carbonate mine is in the western part of the district near the north side of the Lincoln road. The mine has not operated for several years. It is reported that 2,500 tons of lead-zinc ore was taken out in 1945 by the Swansea Mines, Inc., and this company bought the mine, and plan to reopen it in the coming summer. A 75 ton mill was erected in the summer of 1944.

The same gabbro-diorite sill that occurs at the Mike Horse is found at the Carbonate mine, and also cutting the sill is a decomposed rhyolite dike, both being intruded into argillite country rock. Ore minerals are galena, sphalerite, silver, and gold. Sericite, pyrite, and quartz occur as gangue minerals.

Midnight

The mine, on the west side of Shoue Creek, is developed by several adits which are partially caved now. The mine is owned by the Midnight Copper Mining Company, whose agent is L. R. Spogen of Red Lodge. The mine last operated in 1926, is reported to have 2,000 feet of tunnel (45). Specimens from the dump show galena, sphalerite, and some bornite, and pyrite is sprinkled through the ore and wall rock.

Calliope

The Calliope, the first mine in the district, was discovered in 1889 by William Heddleston and George Padburg. The mine is on the ridge between Shoue Creek and Pass Creek. In the first six

years of operation, $11,000 in gold was recovered from workings said to consist of an 80 foot shaft and a 300 foot adit (46). The ore was deposited in two pipe-like bodies in the rhyolite, and gold came from the iron oxides in the ore.

Anaconda

The Anaconda mine is on the slope north of Blackfoot River opposite Mike Horse Creek. The mine was developed by a shaft, and two adits which are now caved. It is reported that the ore deposits and country rock of the mine are quite similar to the Mike Horse geology. The author was not able to find out the name of the owner, but C. B. Lauch and C. M. Kelly, both of Helena, are reported to have cyanided 1,520 tons of old tailings in 1940. The mine is known also as the Andrew Brown property (47, 48).

Milliron, Carbonate Hill, and Eureka Group

These mines are located on the east slope of Pass Creek about a mile north of Blackfoot River, however, the Pass Creek road was closed at the time of the author's visit to the district. Those familiar with the mines report that the ore was in a crushed fault zone in a trachyte dike which intruded the argillites, and that the gold occurred in the iron oxides. The deposits were developed by open pits and shallow shafts, but there has been no work done since the start of the war.

Paymaster

The Paymaster mine is on the north side of the valley of Blackfoot.

47. Mineral Year Book, 1940.
River. The adit entrance into the mine is now caved, and the mine has not been worked for a number of years. Pieces of gabbro and argillite were found on the dump. Galena, sphalerite, tetrahedrite, and probably gold and silver are the ore minerals.

Iron Hill and Skyscraper

These mines are on the slope south of Blackfoot River not far from the Anaconda mine. The deposits are said to be in a shear zone containing a low grade lead-zinc ore.

Rex Beach and Consolation

These mines are on the east slope of Pass Creek. The country rock is the gabbro sill. The ore deposits are said to be in a northwest trending shear zone, and the ore minerals are galena and sphalerite with pyrite, quartz, and sericite as gangue minerals. Gold and silver are also reported. As elsewhere in the district, the valuable minerals occur in shoots. There is no information available on the production and development of the mines. The Consolation, owned by Thompson and Horner, Thurber Printing Co., Helena, Montana, was leased and operated by Tom Ryan, Wilborn, in the early thirties (49).

POORMAN DISTRICT

LOCATION

The Poorman area as described here is the west portion of the Stemple-Gould mining district. The area is drained by the South

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Fork and North Fork of Poorman Creek, and by Seven-up Pete Creek. The Lincoln-Helenaroad by way of Stemple passes through the valley of the North Fork of Poorman, and a branch road goes through Gould, and the valley of the South Fork of Poorman. Another branch of the road runs from the top of the Divide just above Stemple to Lincoln through Seven-up Pete Gulch. From the top of the Continental Divide, it is about 35 miles to Helena, and 20 miles to Silver, the closest shipping point. The area lies on the west slope of the Continental Divide and its spurs, and in the intervening valleys which are narrow with steep sides.

GEOLOGY

The district is underlain by the Belt sediments of the Spokane and Helena formations, which have been intruded by a quartz diorite mass. Along the igneous contact, these sedimentary argillites and argillaceous limestones have been altered to a hornstone. The igneous body extends from Gould to the lower part of Poorman Creek. Its top is not completely exposed as shown on plate 1.

ORE DEPOSITS

The ore bodies are filled fissures and replaced country rock, composed mainly of quartz with metal-bearing stringers. In this district, calcite also appears as a gangue mineral. The ore minerals include galena, chalcocite, their oxidized products, gold, and silver.
MINES

Silver Bell

The Silver Bell mine of the Swansea Mines, Inc., about 12 miles from Lincoln, is located on a spur of the Continental Divide between the North Fork of Poorman Creek and Humbug Creek. The last reported shipment to the East Helena smelter was in 1941.

The mine is developed by an adit and a 150-foot winze. It is not planned to develop the mine below the adit level until the upper ore body is mined out. Cross-cuts are now being driven to develop known ore bodies, and the mine will be stoped out by a block caving method using long diamond drill holes to make the blast. L. C. Hewitt, president and manager at the mine, reports an ore body 500 feet thick and 60 feet wide above the haulage level (50). The zone is composed of about 90 percent quartz, and fractures in the quartz are filled with copper and lead minerals carrying gold and silver. The ore above the level is oxidized, but below the adit level, the ore changes to primary galena and chalcocite or tetrahedrite. Also the percentage of copper is reported to increase with depth. The value of the oxidized ore was given as lead 1%, copper 3 to 3½ percent, gold 0.05 ounces per ton, and silver 30 ounces per ton.

A 200-ton flotation mill is being erected near the mine entrance, and a power line will be installed between the mill and the Montana Power Company's line four miles away.

Plate 6

Haulage adit at the Silver Bell

Silver Bell mill
Prize

The Prize mine is at the head of the South Fork of Poorman on the west side of Granite Peak. Gold is said to occur in iron oxides, whereas the copper-stained ore is said to be barren of gold. Production from the mine has been intermittent. The mine was last worked in 1939 by the Granite Butte Mines Company, but no production figures were given. There is no activity at the present time.

Crown

The mine adjoins the Prize mine. The ore contains gold and silver. The mine was operated in the early thirties by its owners, A. H. Stewart of Great Falls and W. F. Hoge of Wilburn (51). It is developed by several shafts about 700 feet deep, and a few hundred feet of drifts on the vein, which is from 2 to 10 feet in width. No production figures were obtainable, and there is no operation at the present time.

Cyclone

The Cyclone mine is about 13 miles south of Lincoln on the South Fork of Poorman Creek. The gold occurs in iron oxides. At the present time the mine is idle, but it will be reopened on the completion of a 40-ton mill. The Stannsall Bros. of Lincoln are now refitting the mill.

Columbia

The mine is at the head of Seven-up Pete Gulch. The value of the ore is in gold and silver. The mine is developed by a 300 foot...
shaft and three levels. The mine has not been worked for a num-
ber of years.

Last Chance (Donnelly) and Rover (Erickson)
These two adjoining mines are at the head of Seven-up Pete Gulch.
MRS. G. H. DONNELLY of Helena owns the Last Chance mine, and the
Rover is owned by S. Erickson, also of Helena. In the early thir-
ties, both mines were operated by the Donnelly-Erickson Mines Syn-
dicate, H. E. Longmaid of Helena, agent. The Mines were worked
through the 900 foot adit of the Last Chance mine. The Rover is
said to have 1500 feet of drifts (52). The value of the ore is
in gold and silver, however, production figures were not obtain-
able. The mines are not operating at the present time.

LINCOLN DISTRICT

LOCATION
The district includes Lincoln on the north bank of Blackfoot River,
Sauerkraut, Liverpool, Keep-Cool, and McClellan gulches, and Copper
Camp in the vicinity of Stonewall Mountain. The broad, flat val-
ley of the Blackfoot River in this region is cultivated. The dis-
tance from Lincoln to Helena, either by Stemple Pass road, or the
Flesher Pass road, is about 60 miles. Another road runs up Black-
foot River from Missoula, however, this road is usually closed dur-
ing the winter months. A new highway, which will run through the
valley, will when completed connect Lincoln with Great Falls and
Missoula the year around.

52. Directory of Montana Mining Properties; Mont. Bur. Min. Geol.,
Memo No. 15, 1935.
GEOLOGY

The country is underlain by the rocks of the Belt series which are intruded diorite sills and stocks. Glacial drift covers the floors of the major valley, and also the joining northern gulches, however, the small valleys coming in from the south were not glaciated. There are a few low grade gold-bearing veins associated with the diorite and granitic bodies in Lincoln gulch and elsewhere. But by far the greatest amount of gold was recovered from the placer deposits in the area. Apparently gold lodes near the heads of the different gulches were eroded away, and the gold was concentrated in the stream bottoms. Glacial moraines in general are barren of gold. Bodies of oxidized copper ore are reported in the vicinity of Stonewall Mountain. Due to the lack of roads, these deposits have not been developed.

MINES

Lincoln Gulch

The narrow steep-sided valley of Lincoln Creek joins the Blackfoot valley four miles west of Lincoln. This is one of the few northern gulches free of glacial deposits. The placer ground of Lincoln gulch is said to have been very rich, and it is reported that $7,000,000 in gold was recovered in six years after its discovery in 1865 (53). The early miners worked the placers by ground sluicing, open pit, and hydraulic methods. Where the barren overburden was thick, shafts were sunk, and the gold mined by tunneling. Production decreased after 1871. The first dredge, a dry-land washer, was in-

stalled in 1931. Since then several companies have operated dredges in the area, the last to operate in the gulch being the Lincoln Metals Company's dredge. This dredge has not operated in recent years, and was removed from the district in 1946. Because of the tungsten recovered from the black sand, the Government allowed the dredging to continue during the war. There is no placer activity in the gulch at the present time.

The Lincoln Metals Company, of which Mr. George Pauval of Missoula is the agent, owns the Blackfoot mine on the west side of the valley near the mouth of Lincoln gulch. A low grade gold ore is mined in a north-trending shear zone within the diorite sill. The development consists of an adit and cross-cuts totaling about 1,000 feet. The mine was not working when the author visited the property, and the equipment in the mill building had been removed. It is reported by the residents of Lincoln that the Company plans to reopen the mine soon. A test shipment sent to East Helena smelter only averaged $2.00 to $3.00 a ton, but the mine has a large reserve of this low grade ore. If a cheap mining method can be developed, the mine has good possibilities of becoming a successful producer.

McClellan Gulch

McClellan gulch, a short south-flowing tributary of Poorman Creek, is eight miles south of Lincoln. The stream cuts Belt argillites and quartzites. The placer gold found in the stream bed apparently came from lodes in the granitic stock at the head of the gulch. There are no glacial deposits in the valley bottom. The placer gold occurs in two separate buried channels, probably a stream channel and a bar channel. It is reported that nearly $7,000,000 in gold
was recovered before 1875 by ground sluicing and hydralicking methods (54). The gold occurs as nuggets about the size of wheat grains, but in 1927 one nugget weighing 57 ounces was found. There has been no mining activity recently in the gulch, but it is reported that a Denver concern will test the upper part of the gulch this coming summer with the view of installing a washer.

Sauerkraut Gulch

Sauerkraut Creek is a south tributary of Blackfoot River below Lincoln. A limy argillite underlies the area. In the lower part of the gulch, much glacial drift was deposited by glaciers from the north, and only in the upper portions of the gulch, where the glacial deposits are thinner, can placers be worked. The places where the gravel contained large boulders was worked by a method known as booming, a process where ground sluicing is done with heavy rushes of water from a reservoir.

Keep Cool, Liverpool, and Stonewall Creeks

These streams are north tributaries of the Blackfoot River in the vicinity of Lincoln. Small amounts of placer gold have been recovered from the stream bottoms, but thick deposits of glacial moraines interfere with the placer mining. The last activity in the area was in Stonewall Creek where the Stonewall Gold Mining Company, H. K. Newman of Conard, agent, operated a dry-land washer and two shovels on the Osgood placer (55).

FINN DISTRICT

LOCATION

Finn is about 15 miles north of Avon, a station on the Northern Pacific Railroad. The district includes that portion of the west slope of the Continental Divide which is drained by the streams of Washington, Jefferson, Buffalo, American and Nevada gulches. A well graded county road connects Avon with Finn.

GEOLOGY

The area is underlain by rocks of the Belt series, and the Spokane is the highest Belt formation in the region. Volcanic rocks occur along the west slope of Nevada Creek. Near the heads of the gulches and along the ridge top, the Belt sediments are cut by a granitic stock which contains low grade lead-gold veins. Most of the production in the district has come from placer deposits which have been worked by small companies using dry-land dredges and individual miners working with a pan and sluice box. With the exception of a small area in Jefferson gulch, the placers have been so thoroughly worked that it would be unprofitable for a new large scale operation. Placer miners reworking the old tailings and stream banks with a wheelbarrow and sluice box, are able to recover from 4 to 5 dollars in gold a day. During times of depressions, many miners enter the area to make their living with the gold pan.
Washington Gulch

A moderate amount of placer gold was produced, most of which prior to 1890 came from Washington gulch. The placers have been active for many years with miners taking out 1,000 to 3,000 dollars a year by sluicing and hydralicking. Between 1930 and 1940 the gulch was thoroughly worked over with the dry-land dredges of the El Dorado Gold Placer Mining Co. and the Washington Gulch Leasing Co. Mr. Ted Kieley (56) of Finn reports that no unworked placer ground left is in the gulch. The El Dorado Gold Placer Mining Co. of which Mr. H. M. McCulloch of Spokane, Washington, is president, operated with a dry-land dredge and two dragline shovels. The average daily capacity was 800 cu. yd. of overburden stripped and 300 cu. yd. of pay dirt.

The Grey mine and Shamrock mine are the only mines reported working in the last ten years. The Grey was worked last in 1938 by the Great States Gold Mining Company. Approximately $10,000 was produced. Four men are normally employed. The Shamrock mine of the Shamrock Mines, Ltd., was closed in 1941. Its average annual production is 20 ounces of gold, 25 ounces of silver, and 700 pounds of lead. It is reported by the ranchers in the district that the company is planning to reopen the mine this summer.

Jefferson Gulch

The placer ground has been worked by sluicing and hydralicking methods. The Wiggins mine of the Evans Metal Mine Company, 8 miles 56. Kieley, Ted, personal communication.

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56. Kieley, Ted, personal communication.
Two views of the El Dorado dredge operating in Washington gulch in the summer of 1936. Similar dredges have operated in Lincoln, Sauerkraut, Mc Clellan, and Stonewall gulches.
north of Finn, is on three unpatented claims and one patented claim. It is developed by 4 adits, 185, 80, 60, and 20 feet in length, and 700 feet of drifts and cross-cuts (57). The mine is open for a short period every year. Near by the mine, a 25-ton amalgamation mill treats the ore. Mr. C. B. Davis now has the mine under lease. The Sprakel property is 1½ miles from the Wiggins mine. It consists of 1 patented placer claim and 1 unpatented lode claim which is worked by an open pit. There was no mining activity in the gulch during 1946 and the first part of 1947.

Madison Gulch

Mr. R. W. Cumb and Mr. Dan Piper operated a washing plant in Madison gulch from August to October, 1945, and this is the last reported operation in the Finn district. They recovered 30 ounces of gold. There will no doubt be placer miners reworking the old tailings and stream banks with their pans and sluice boxes for many years to come. But their production will be small, and most likely never accurately reported.

HELLEVILLE DISTRICT
(Big Blackfoot)

LOCATION

The area includes the mines of Odgen, 7 miles northeast of Hellsville, and Markham mountains, 10 miles north of Helenville, which in turn is 27 miles northwest of Avon. During the winter months the Odgen mountain region is not accessible. The production has

come from small placers and lode mines which are usually worked by individual lessees or small companies.

GEOLOGY

The mountains in this region are composed of the Appekunny, Grinnel, and Newland formations. In the Markham and Dalton mountains, a diorite sill separates the Appekunny and Grinnell formations, and in the Odgen Mountain region, a small granitic stock intrudes the Belt sediments. Gold from the erosion of lodes on Odgen Mountain has been concentrated along the stream bottoms of the area. Prof. O. A. Dingman reports that the placers of Odgen, although limited to a relatively small area, are among the richest in Montana. The lode mines, in which the ore minerals are mostly galena and gold with minor amounts of silver and copper, are associated with the igneous rocks. An outcrop of oxidized copper minerals is exposed near the Blackfoot gold mine on Odgen Mountain, although this vein has never been worked.

MINES

Blackfoot Gold

The Blackfoot Gold mine is also often referred to as the Hilda mine. The mine entrance is located near the top of the west slope of Odgen Mountain, 10 miles northeast of Helmville. The steep road leading up to the mine is usually closed during the winter months.

The veins are in a granitic rock which is very similar to the monzonite of the Butte district. They have a general trend of N. 55-60° W., and dip 30° N.E. The width of the ore bodies range from 3 inches to 36 inches with an average of 10 inches, and the ore is mainly
quartz with stringers of galena in the quartz. Galena carries the gold values.

The mine has been developed by three adits totaling about 2000 feet. The last shipment, was made in 1942.

**Hobby Horse**

The mine is owned by the Odgen Mountain Mining Company, of which Mr. C. N. Bielenberg of Deer Lodge is the agent. The mine is one-half mile west of the Blackfoot Gold mine, and it is said to be developed by a 160 foot shaft. The owners were building a new road to the mine in the summer of 1946, and during the coming summer they plan to drive an adit which will connect with the bottom of the shaft. The last shipment of ore, which contained lead and gold, was made in 1937.

**Higgins**

The Higgins mine, owned by Mr. E. L. Stout and Mr. D. Fleming of Helmville, is a mile down the gulch from the Blackfoot Gold, on Shores Creek. The vein contains gold, silver, and lead, and the country rock is granite. The mine has not been worked since 1939, however, the owners plan to do some development work during the coming summer. There is a 300 foot adit on the vein.

**Moose**

The Moose mine of Jack MacEacheron, Butte, on the Moose creek, has not operated in recent years. It is said to have 300 feet of tunnels. The mine has not been worked for a number of years.

**Miller**

The Miller mine is on Markham Mountain, ten miles north of Helmville.
Views 1 and 2 show Markham mountain cut with prospecting trenches. The H & H Mining Company used a D-8 'Caterpillar' tractor with a bulldozer blade to do the trenching.

Views 3 and 4 show two cross-cuts which were driven in 1946 to intersect the veins exposed in the trenches above. The adit in 3 intersected a vein in a hundred feet. The adit of number 4 was not finished last April at which time the mine was not in operation.
The H & H Mining Company of Spokane has been driving prospecting cross-cuts into the hillside to uncover lead-gold bearing veins. In the summer of 1946, the Company dug trenches on the surface with a bulldozer to discover the surface outcrops.

As yet no stoping operations have been carried on by the Company. Although the mine was idle during the winter, the management plans to do more development work in 1947.

SUMMARY

The Blackfoot area is underlain by the thick sediments of the Belt series which consists of red and green argillites, quartzites, and impure limestones. Paleozoic and Mesozoic rocks are absent in this region, but are found in the adjacent areas to the south and east. Cenozoic lake beds, glacial deposits, and alluvial till cover the valley bottoms.

The Beltain rocks apparently were deposited during times of a shallow, undulating sea. Probably Paleozoic and Mesozoic beds were laid down over the entire area, only to be eroded away during and after the uplift. Mountain building stresses were not active until late Cretaceous or early Eocene time, but during the uplift, a series of northwest trending mountain ranges were formed. Long parallel overthrust faults separate the ranges from each other. After the release of stresses by overthrusting, normal faults developed. In the Cenozoic era, lakes were formed when uplift and glaciers blocked the river channels. The mountains were glaciated later by alpine glaciers.
Associated with the mountain building processes were intrusions of igneous rocks, resulting in small granitic stocks, gabbro-diorite sills, and diorite-trachyte dikes, which cut the sedimentary rocks. Later there were extrusions of andesite and rhyolite lava. Mineralizing solutions accompanied or closely followed the igneous activity. The principal ore minerals in the area are galena, gold, silver, and sphalerite, and copper minerals occur in minor amounts. Ore bodies were formed in shear zones, breccias, and fissures, forming veins and lodes.

Moderate amounts of gold have been recovered from the placer deposits, most of the placer production having been before 1900. The lode deposits have been worked intermittently for many years by small companies and lessees, however, it was not until 1941 that one of the lode mines started to produce in any quantity. Within five years, the annual value of the Mike Horse mine production jumped from a few dollars to over a million dollars. It is possible that other mines will become leading producers in the future.
LEGEND

MINES

1. HEDDLESTON DISTRICT
   a. MIKE HORSE
   b. ANACONDA
   c. IRON HILL
   d. SKYSCRAPER
   e. CONSOLATION
   f. REX BEACH
   g. MIDNIGHT
   h. CALLIOPE
   i. MILL IRON
   j. CARBONATE HILL
   k. CARBONATE
   l. PAYMASTER
   m. EUREKA

2. POORMAN DISTRICT
   a. CROWN
   b. PRIZE
   c. CYCLONE
   d. SILVER BELL
   e. LAST CHANCE
   f. ROVER
   g. COLUMBIA

3. LINCOLN
   a. LINCOLN GUL.
   b. MC CLELLAN GUL.
   c. SAEGERKRAUT GUL.
   d. LIVERPOOL GUL.
   e. STONEMALLY GUL.& MTN.
   f. TOTTER

4. FINN
   a. WASHINGTON GUL.
   b. SHAMROCK GREY
   c. JEFFERSON GUL.
   d. BUFFALO GUL.
   e. AMERICAN GUL.
   f. MADISON GUL.

5. HELMVILLE BIG BLACKFOOT
   a. BLACKFOOT GULD
   b. HOBBY HORSE
   c. HIGGINS
   d. MILLER

ROADS & TRAILS

CONTINENTAL DIVIDE

STREAMS

COUNTY LINE

SCALE
EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

ALLUVIUM GLACIAL DRIFT
Undifferentiated clay, sand & gravel

TERTIARY

LAKE BEDS
Clay, sand, gravel, some volcanic tuffs

CRETACEOUS

MONTANA, COLORADO KOTENAI Fms
Shale, sandstone, some conglomerate limestone

JURASSIC

LOWER KOTENAI ELLIS Fms
Shale, limestone & sandstone

CARBONIFEROUS & CAMBRAIN, DEVONIAN

UPPER PALEOZIOIC limestone & shale
LOWER PALEOZIOIC limestone & shale

MISSOURI GROUP
Red, purple & green argillites & quartzites.

SIYEH or WALLACE GROUP

HELENA FORMATION
Thin bedded siliceous argillaceous limestone & calcareous argillite

SPOKANE FORMATION
Red & green argillites & quartzites

NEWLAND FORMATION
Dolomite, argillite & quartzite

RAVALLI GROUP

GRINNEL FORMATION
Red with some green argillite & sandstone

APPEKUNNY FORMATION
Dark argillite quartzite & quartzitic argillite

igneous rocks

VOLCANIC ROCKS
Chiefly andesite, also rhyolite, dacite & basalt

GRANITIC ROCKS
Chiefly quartz monzonite, forming stocks

GABBROIDAL ROCKS
Gabbro, diorite & gabbro diorite forming sills, dikes, & irregular stocks