Reconnaissance Survey of the Geology and Ore Deposits of the Southwestern Portion of Lemhi Range, Idaho

By
Roy A. Anderson
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>3</td>
</tr>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>.............................. Purpose of the Study ..........................</td>
<td>3</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>3</td>
</tr>
<tr>
<td>Geography</td>
<td>5</td>
</tr>
<tr>
<td>.............................. Location of the Area .........................</td>
<td>5</td>
</tr>
<tr>
<td>Physiography</td>
<td>5</td>
</tr>
<tr>
<td>.............................. Vegetation and Soil Cover ..................</td>
<td>6</td>
</tr>
<tr>
<td>Culture</td>
<td>6</td>
</tr>
<tr>
<td>Geology</td>
<td>6</td>
</tr>
<tr>
<td>.............................. Igneous Rocks ..............................</td>
<td>6</td>
</tr>
<tr>
<td>Metamorphic Rocks</td>
<td>6</td>
</tr>
<tr>
<td>.............................. Sedimentary Rocks .........................</td>
<td>7</td>
</tr>
<tr>
<td>.............................. General Character ........................</td>
<td>7</td>
</tr>
<tr>
<td>.............................. The Quartzite Series .......................</td>
<td>8</td>
</tr>
<tr>
<td>.............................. Pink Quartzite ............................</td>
<td>8</td>
</tr>
<tr>
<td>.............................. Maroon Shale and Quartzite ................</td>
<td>8</td>
</tr>
<tr>
<td>.............................. Upper White Quartzite .....................</td>
<td>8</td>
</tr>
<tr>
<td>.............................. Gray Dolomite ..............................</td>
<td>9</td>
</tr>
<tr>
<td>.............................. Black Shale .................................</td>
<td>9</td>
</tr>
<tr>
<td>.............................. Shaly Limestone ............................</td>
<td>9</td>
</tr>
<tr>
<td>.............................. Coral-Bearing Limestone ...................</td>
<td>9</td>
</tr>
<tr>
<td>.............................. Alluvial Fans and Valley Fill ..........</td>
<td>9</td>
</tr>
<tr>
<td>Structural Geology</td>
<td>9</td>
</tr>
<tr>
<td>Ore Mineralization</td>
<td>11</td>
</tr>
<tr>
<td>Description of Mining Properties</td>
<td>13</td>
</tr>
<tr>
<td>.............................. Ajax ...........................................</td>
<td>13</td>
</tr>
<tr>
<td>.............................. Buckhorn .....................................</td>
<td>13</td>
</tr>
<tr>
<td>.............................. Copper Mountain ............................</td>
<td>13</td>
</tr>
<tr>
<td>.............................. Daisy Black .................................</td>
<td>13</td>
</tr>
<tr>
<td>.............................. Great Western ...............................</td>
<td>14</td>
</tr>
<tr>
<td>.............................. Johnson Property ...........................</td>
<td>14</td>
</tr>
<tr>
<td>.............................. Protection ....................................</td>
<td>14</td>
</tr>
<tr>
<td>.............................. Sentinel ......................................</td>
<td>14</td>
</tr>
<tr>
<td>.............................. Whiterock ....................................</td>
<td>14</td>
</tr>
<tr>
<td>.............................. Wilbert .......................................</td>
<td>18</td>
</tr>
<tr>
<td>Recommendations for Further Prospecting</td>
<td>18</td>
</tr>
</tbody>
</table>

### ILLUSTRATIONS

- **Figure 1. Index Map Showing Area** ............................................. 4
- **Figure 2. Stratigraphic Section** ............................................. 7
- **Figure 3. Sketch Showing Workings of Johnson Property** ............... 15
- **Figure 4. Sketch Showing Workings of the Sentinel Mine** ............... 16
- **Figure 5. Geologic Map of Southwestern Portion of Lemhi Range** ...... 19
- **Figure 6. Vertical Structure Sections** .................................... 20
- **Plate I-A. Nodular Quartzite Showing Arrangement of the Nodules** .... 10
- **Plate I-B. Coral Limestone of Striped Peak** ................................ 10
- **Plate II-A. Front Fault Scarp as viewed from Northwest** .............. 12
- **II-B. Contorted Coral Limestone on Crest of Lemhi Range** ............. 12
- **Plate III-A. Wilbert Mine, North Creek Canyon** .......................... 17
- **III B. North Creek Canyon with Daisy Black Working** ................... 17
Reconnaissance Survey of the Geology and Ore Deposits of the Southwestern Portion of Lemhi Range, Idaho

by

ROY A. ANDERSON

ABSTRACT

The rocks of the southwestern portion of the Lemhi Range, Butte County, Idaho, consist of over 5350 feet of Paleozoic sediments which lie unconformably on a series of metamorphic rocks of probable pre-Cambrian age. A small basaltic flow at the crest of the range and lamprophyric dike material were the only igneous rocks noted in the area.

The Paleozoic series consists of quartzite, gray dolomite, black shale, shaly limestone, and coral-bearing limestone, each of which were mapped as separate units on the geologic map. Fossils of Upper Ordovician age were collected from the gray dolomite series. Fossils of Carboniferous (Brazer) age were collected from the coral-bearing limestones.

The Paleozoic beds have been highly contorted by folding and in some instances by overthrust faulting. Movement along northwesterly trending block faults is responsible for the uplift of the present mountain range.

Mineralization occurs along zones of faulting and bedding planes within the quartzite series and in sandy portions of the gray dolomites. Carbonatization of the quartzite and of the sandy dolomite apparently was a major process accompanying ore mineralization.

Valley fill and alluvial fans of Cenozoic age are widespread in the valley bottoms and constitute important geologic features.

INTRODUCTION

PURPOSE OF THE STUDY

Interest has long been evidenced in the possibilities of developing a lead mining industry in the southwestern portion of the Lemhi Range. The Idaho Bureau of Mines and Geology undertook a reconnaissance investigation of the area during the summer of 1947. About seven weeks were spent in the field.

Umpleby, Ross, and Anderson had previously made brief visits to the region. Their time was devoted almost exclusively to the Wilbert Mine. These investigations indicated that a problem of structural relationship and paragenesis existed.

The purpose of the present investigation was a surface study of the geology to determine the relationships between mineral occurrences and the stratigraphic and structural features. This work resulted in the preparation of a reconnaissance geologic map. The information thus gained suggests that ore deposit was controlled by lines of faulting which trend northwesterly and are confined to quartzite and limestone lying fairly close to the lines of faulting on the southwest side.

The history and production of the Wilbert Mine has been summarized to 1933 by Ross, who found that well over $2,000,000 worth of lead and silver had been produced. Other mines and prospects in the area are potential producers. Regional prospecting of this region should be planned, and it is believed that the accompanying map and report will prove useful as a guide for future prospecting and development.

ACKNOWLEDGMENTS

Mr. Jack Smedley assisted in the field, and Mr. Richard Adelmann aided in the preparation of the maps and sketches. Mr. Clarence Dye and Mr. Roy Hawley of Howe, and Mr. W. A. Barnes and Mr. Dayle of Arco supplied information from their intimate knowledge of the district.

4 Ross, C. P., op. cit., pp. 3-3.
GEOGRAPHY

LOCATION OF THE AREA

The region studied is entirely in Butte County. It comprises all or part of the area within Ts. 6 to 9 N. and Rs. 28 to 30 E. of the Boise Meridian. The area lies principally within the Challis National Forest, Lost River Division.

A reconnaissance study was made north of Uncle Ike Creek as far as Badger Creek in order to seek additional mapping of this part of the region. No mapping was done in this area due to lack of time. A continuation of this study to the north would be desirable.

The region is accessible by automobile from the village of Howe to the base of the Lemhi Range for nearly its entire length by driving up the gently sloping alluvial fans. Passable roads exist into the valleys of Badger Creek, Boulder Creek, Uncle Ike Creek, North Creek, Camp Creek, South Creek, and Black Canyon.

PHYSIOGRAPHY

Physiographically the area is located on the southwest slope of the Lemhi Range. It is bounded on the northwest by Uncle Ike Creek, on the southwest and south by the Little Lost River valley, and on the east and northeast by the crest of the Lemhi Range.

The relief of the area is approximately 5000 feet. Little Lost River, which flows along the west side of Lemhi Range, is about 5500 feet above sea level. The crest of the range is about 10,500 feet. Enormous alluvial fans, typical of semi-arid regions, flank Little Lost River on either side. The channel is confined to a relatively narrow river flat. The length of the alluvial fans from their upper contact with the base of Lemhi Range to their front is as much as seven miles.

The Lemhi Range has been described as a dissected fault block segment of an ancient erosion surface. A more or less even crestline of the range corroborates this explanation. Physiographic evidence for two periods of uplift was observed.

The existing wind gaps in the Lost River Range and in the Lemhi Range have been described by Anderson as representing the course of drainage over this area previous to the block faulting which produced the present mountain ranges. During the uplift of these northwest trending blocks, a drainage pattern was developed by the initial streams flowing normal to the trend of the block, thus accounting for the courses of the main streams draining the area. During this time most of the dissection of the mountain block took place until the drainage pattern became quite well established and the streams approached grade in their lower courses. There was some glaciation during this time as exhibited by glaciofluvial deposits along the upper portions of the stream valleys together with the occurrence of glacial cirques formed by valley-head glaciers.

A more recent uplift of the fault blocks is suggested by the rejuvenation of the streams in their lower courses, bringing about a dissection of the alluvial fans and the development of narrow steep walled canyons in the lower courses of the streams. This "hourglass" valley pattern is suggestive of recently uplifted areas.

Some rather recent block fault movements are exhibited by the escarpment along the highway in Sec. 21, T. 7 N., R. 28 E. (See Plate IIIA).

Of the streams draining the area, the wind gap at the head of Uncle Ike Creek is apparently the only drainage antecedent to the first block faulting movement. The present courses of Uncle Ike Creek, North Creek, Camp Creek, and South Creek are consequent and originated on the front of the Lemhi Range block following the first block faulting movement.

Subsequent control by bedding planes and fault lines has determined parts of these stream valleys, and to a greater degree has influenced the course of the tributaries. The course of the upper part of Black Canyon is attributed to this control as it follows the trend of the Black Canyon fault. (See geologic map.) The softer red and black shale outcrops can be traced in some places as canyons and low divides.

It is worth noting that the waters of Uncle Ike Creek, North Creek, and South Creek, although of small volume, are permanent streams instead of being intermittent in such a dry area. Talus slides, cavernous limestones, and the brecciated quartzites along the fault zones probably contain enormous reservoirs for the storage of the moisture accumulated during the rainy periods.

The mountain streams, after emerging upon the alluvial fans, soon sink into the porous gravels before reaching the Little Lost River. Small farms at the mouths of these canyons utilize much of this water for irrigation. More than likely the gravels which fill the Little Lost River valley contain an abundance of water at depth. No information was obtained regarding the ground water supply of the valley.

Anderson, A. L., idem.
VEGETATION AND SOIL COVER

Vegetation is sparse and does not interfere with the geologic work. Sagebrush was quite abundant from the base of the mountains outward upon the alluvial fans and in the Little Lost River valley. Buckbrush, flexible pine, and fir growth were found generally on the north slopes and were sufficiently thick in spots to hinder observations. Probably less than fifty per cent of the mountainous region is forested. Mountain mahogany is more prevalent on the east and south sides of the range, which suggests greater aridity than the area covered by coniferous forests. Bear grass along the streams draining the west side of the range is suggestive of a shallow ground water table.

Sufficient timber suitable for most mine timbers exists in the area, although there is hardly enough to support lumbering as an industry.

The mountainous area is more suitable for stock grazing than for any other line of agriculture.

Above timber line, about 9000 feet, talus slopes cover the bedrock. Rock structures are prominently exposed along the crest of the range and to a lesser degree on the lower slopes.

CULTURE

The villages of Howe and Berenice are the centers of an extensively irrigated tract of land. Water is ditched to the farms from the Little Lost River.

The most prominent mining camp in the area is at the Wilbert Mine. Facilities include a group of cabins, which serve as living quarters for the miners, a boarding house, and other necessary mine buildings. Ranches and sheep stations occur scattered throughout the area. The mountainous region is largely uninhabited except for isolated prospectors' camps.

Gravel and surfaced highways connect the area with Arco and larger towns to the south. The nearest railroad point is Arco.

Electric power is available through the lines of the Utah Power Company.

GEOLOGY

IGNEOUS ROCKS

The only igneous rocks noted were the lamprophyre dikes of the Wilbert Mine described by Ross1 and Anderson2; a small valley flow of basaltic material exposed at the head of Pass Creek in Sec. 5, T. 8 N., R. 29 E.; and basaltic dike material from the mouth of Badger Creek in Sec. 30, T. 9 N., R. 28 E.

The age of the lamprophyre intrusion has not been definitely determined. Anderson3 places the age of the dikes found at the Wilbert Mine in the early Tertiary and classifies them as apparently pre-mineral and about the same period as the mineralization.

The valley flow at the head of Pass Creek may be further correlated with the basaltic flows which extend into Birch Creek from the Snake River Plains. They are possibly Pliocene age4.

The basaltic material at the mouth of Badger Creek is beyond the limits of the area studied.

In no other portion of the area were igneous rocks observed although there is reason to believe that igneous solutions reached a relatively shallow depth beneath the present surface. This is suggested by the feldspathization of the quartzite and the metamorphic series. Further evidence of the feldspathization is given by Anderson5.

METAMORPHIC ROCKS

A series of well-beded, gray, siliceous slates over 650 feet thick with interbeds of brown and red quartzite up to four feet thick were the oldest rocks recognized. A distinct angular unconformity is found between this series and the overlying quartzites. The metamorphic series is exposed along the western base of the Lemhi Range at the mouth of South Creek canyon. Outcrops of this material occur at the mouth of Uncle Ike Creek and northwestwardly beyond the mouth of Badger Creek Canyon. It is possible that this material is continuous to where the Belt series rocks are exposed in the vicinity of Schwager Reservoir.

1Ross, C. P., op. cit., pp. 5-6.
# STRATIGRAPHIC SECTION OF THE SOUTHWESTERN PORTION OF LEMHI RANGE, IDAHO

<table>
<thead>
<tr>
<th>Description</th>
<th>Thickness Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>?</td>
</tr>
<tr>
<td>Alluvial Fans, Valley Fill</td>
<td>?</td>
</tr>
<tr>
<td>Tertiary</td>
<td>?</td>
</tr>
<tr>
<td>Valley Basalt flows</td>
<td>?</td>
</tr>
<tr>
<td>Lamprophyre dikes</td>
<td>?</td>
</tr>
<tr>
<td>Paleozoic</td>
<td></td>
</tr>
<tr>
<td>Coral-bearing limestone</td>
<td>2000+</td>
</tr>
<tr>
<td>Shaly limestone</td>
<td>450</td>
</tr>
<tr>
<td>Black shale</td>
<td>400</td>
</tr>
<tr>
<td>Gray dolomite</td>
<td>500</td>
</tr>
<tr>
<td>Quartzite</td>
<td></td>
</tr>
<tr>
<td>Upper white quartzite</td>
<td>1000</td>
</tr>
<tr>
<td>Maroon shale and quartzite</td>
<td>350</td>
</tr>
<tr>
<td>Pink quartzite</td>
<td>650</td>
</tr>
<tr>
<td>Total</td>
<td>5350+</td>
</tr>
<tr>
<td>Pre-Cambrian Metamorphic</td>
<td>650+</td>
</tr>
</tbody>
</table>

**Figure 2.**

A smaller area of these rocks is exposed in Sec. 33, T. 8 N., R. 29 E., and in Secs. 3, 4, 9, and 10, T. 7 N., R. 29 E. where their position can be explained by block faulting.

This series is essentially a metamorphosed, shaly sandstone which is now made up predominantly of quartz grains about one millimeter in diameter and abundant white mica. Cross-bedding and ripple marks are locally prominent. Cleavage is developed at an angle to the bedding planes and varies in strike from N. 20° E. to N. 40° E. The dip is about 75° Northwest. The beds are highly folded. Frequent white quartz veins containing specularite are found as irregular fracture fillings that do not correspond to the cleavage and bedding planes. Abundant feldspar in this material is found north of the limit mapped.

Specimens of this series were compared megascopically with the Belt series in the vicinity of Moonshine Creek and Schwager Reservoir; they were of similar appearance.

## SEDIMENTARY ROCKS

### General Character

Unconformably over the metamorphic rocks is a series of Paleozoic sedimentaries with a total thickness of over 5350 feet. Umpleby¹², Ross¹³, Kirkham¹⁴, and Anderson¹⁵ have briefly described this sequence of rocks. The age of the gray dolomite, which is next above the quartzite series, has been determined as Upper Ordovician from the fossils found therein.¹⁶

Dr. G. A. Cooper of the U. S. National Museum identified the following specimens collected from the gray dolomite:

- *Dinorthis “subquadrate Hall”*
- *Streptelasma sp.*
- *Platystrophia sp.*

The fossils are of Upper Ordovician age.

---

¹⁴Kirkham, V. R. D., op. cit. p. 16-30.
¹⁶Ross, C. P., op. cit. p. 3.
Miss Helen Duncan and James Steele Williams of the U. S. National Museum identified the following forms collected from the coral-bearing limestone:

- *Stratiolina brasieri* (Girty)
- *Spirifer brasieri* (Girty)
- "Zaphrentis" multilamellosa type
- *Productus* aff. *P. keeuk Girty, 1927*
- *Archimedes* sp.

These fossils are Carboniferous and of Brazer age.

The quartzite series below the gray dolomite, in which no fossils were found, is assumed to be of Paleozoic age because they are conformable beneath the gray dolomite and are distinctly unconformable over the metamorphic series.

C. P. Ross1 has correlated the quartzite at the Wilbert Mine with the Kinnikinik quartzite of the western part of the Bayhorse quadrangle. He has correlated the gray dolomite with the Saturday Mountain formation of the Sawtooth quadrangle, based on a study of lithology and fossil descriptions. The coral-bearing limestone may be correlated with the Brazer limestone of the Bayhorse quadrangle on the basis of lithology and fossil descriptions.

In order to establish a stratigraphic section from which the rock units might be studied, a section was measured between North Creek and Uncle Ike Creek from the southwest corner of Sec. 30, T. 8 N., R. 29 E., to Sec. 21, T. 8 N., R. 29 E. The thickness of the formations may be assumed to be accurate within one hundred feet in the vicinity of the measured section. However, in tracing the beds along their strike, considerable thickening and thinning were noted, which may be explained by original variations in thickness or to distortion induced by folding and faulting.

The rock units were determined on the basis of thickness and lithology rather than upon the geologic period to which they belonged. The Paleozoic section was divided into coral-bearing limestone, shaly limestone, black shale, gray dolomite, and quartzite.

### The Quartzite Series

This series is shown as one unit on the geologic map; however, on the basis of lithology, it may be divided into three parts: A lower pink quartzite about 650 feet thick, the middle maroon shale with associated maroon quartzite beds about 350 feet thick, and an upper white quartzite about 1000 feet thick. At a distance from the measured section a considerable variation was noted in the thickness of the quartzite series. This probably can be attributed to the relief of the erosion surface upon which the quartzite beds were deposited.

### Pink Quartzite

This quartzite is unconformable over the metamorphic series. It consists of about 650 feet of gritty to conglomeratic quartzite with pebbles up to one-half inch in diameter. The pebbles are made up of white crystalline quartz suggestive of material eroded from areas of coarse-grained schists and granites. Bedding planes may be distinguished because of the variation in grain-size. Outcrops of this material usually erode to form vertical cliffs and pinnacles. This differential weathering process is controlled by the vertical jointing. About 500 feet above the bottom of the pink quartzite, a lens of maroon quartzite some 25 feet thick was observed.

### Maroon Shale and Quartzite

Above, and in apparent conformable contact with the pink quartzite, is a 50-foot bed of maroon quartzite. Overlying the maroon quartzite is 250 feet of gray to maroon micaceous shale. Above this is a second 50-foot bed of maroon quartzite.

### Upper White Quartzite

Conformably above the maroon quartzite is a series of white, uniformly fine-grained quartzite beds about 1000 feet thick. Locally, cross-bedding is evident within lenses of slightly coarser sand grains. This formation was affected to a variable extent by carbonating solutions. (Carbonization is the term used by Anderson18 to denote rock-making material which has been converted to carbonates.) Weathered outcrops of the lower 800 feet of this formation exhibit a peculiar type of differential weathering. Small cavities ranging from the size of walnuts to that of baseballs are uniformly distributed over the surface (See Plate 1A). On fresh surfaces of specimens a faint "mottling" was observed. Within each rounded area, or spot, the cementing material contained carbonates of calcium and possibly some magnesium. Weathering acted upon the areas of carbonization more rapidly than upon the pure silica cement; this was prob-

---

ably responsible for the development of the cavities. The “mottled” appearance was noted throughout the lower 800 feet of the measured section. The upper 200 feet were distinguished by the arrangement of the carbonate cement along bedding planes, which resulted in a white banded quartzite. At a distance from the measured section, carbonatization along bedding planes was noted in the lower portion of the white quartzite. Anderson\textsuperscript{14} described carbonatization as one of the processes of the alteration of the wall rock of the Wilbert Mine. Carbonatization of the upper white quartzite is probably associated with a similar process.

**Gray Dolomite**

This series is gradational from the dense, bluish-gray material in the lower part to a sandy variety near the top. The thickness of the series was estimated to be about 600 feet: variations from 400 to 700 feet were noted. The contact between the gray dolomite and the underlying white banded carbonatized quartzite is gradational and is apparently conformable. Fossil forms are locally abundant in the dense limestone. Tetracorals, tabulates, brachiopods, and crinoid fragments were noted. The age of this formation has been determined as Upper Ordovician. The upper half of the bed consists of a sandy-like material. Sandy lenses and brecciated zones within the gray dolomite are the loci of ore mineralization on the Johnson property and at the Sentinel.

**Black Shale**

The lower contact of this formation was not observed although no marked angular discordance was noted. The material is coal black with a somewhat shiny luster and commonly breaks into cubes rather than forming platy pieces. Bedding in the main is indistinct, and no fossils were found. Due to the erosion being rather easily eroded its exposures are evidenced by rounded hills and low saddles. Subsequent tributaries to the main drainage have formed at various places along exposures of the black shale. The measured thickness is about 400 feet.

**Shaly Limestone**

The shaly limestone, upon weathering, changes to distinctive reddish-brown platy fragments. On fresh surfaces the color is gray to light bluish-gray. It is apparently conformable over the black shale, although the contact is usually obscured by surface debris. No angular discordance was noted in the attitude of the two formations. The shaly limestone grades from a nearly pure limestone at the top to a fairly shaly material at the bottom. It is possible that the shaly limestone is a gradational zone between the black shale and the coral-bearing limestone. The measured thickness of the material is about 450 feet.

**Coral-Bearing Limestone**

This limestone is characterized by the presence of well preserved horn corals which often weather out of the rock and are found strewn about the surface. Towards the upper part of the formation, productive-like brachiopods are fairly abundant. Chert nodules and layers are quite common. The higher peaks and ridges of the Lemhi Range are made up of this material. The thickness was not measured, but it was estimated to be over 2000 feet. The age of this series was determined as Brazer.

**ALLUVIAL FANS AND VALLEY FILL**

Enormous deposits of alluvial material of a rather coarse nature extend from the base of the Lemhi Range out toward the center of Little Lost River Valley. This material together with alluvial and glaciofluvial deposits in the valleys of Uncle Ike Creek, North Creek, and South Creek indicates the erosion from the present mountains following their initial uplift and preceding the later uplift of the region. The present streams are incised into the alluvium to depths of as great as 100 feet. Abundant evidence may be found with which to trace physiographic history. Each time of uplift was represented by a new surge of debris from the uplands.

**STRUCTURAL GEOLOGY**

The tectonic history of the region, following the deposition in Paleozoic basins, consists primarily of a period of intense folding with the development of stretch thrusts followed by a period of erosion. A period of block faulting took place during the Tertiary, probably coincident with the development of the basin and range province to the southwest. There is some evidence for a second, more recent period of block faulting.

In general, the sedimentary rocks have a strike roughly parallel to the trend of the Lemhi Range, and they dip to the northeast. The quartzite series have behaved in a somewhat different manner to the tectonic forces than the overlying limestones. The coral-bearing limestone, which makes up the crest of the mountains, is highly contorted, highly buckled folds are the rule. One must be especially observant in this region when making stratigraphic measurements as many of the beds are overturned.

A. Nodular quartzite showing arrangement of nodules.

B. Coral limestone of Striped Peak.
Quartzite has responded to the deforming stresses as a competent rock. It has become fractured and exhibits little of the flowage characteristics associated with the overlying limestone. The mass of quartzite has also responded to thrust movements by breaking at an angle to the bedding planes. The fault planes extend into the limestone where they are usually contained within the bedding planes of the recumbent folds and are nearly horizontal. The overthrust sheet in Sec. 17, T. 7 N., R. 29 E. consists of contorted limestone which has been pushed from the west over folded white quartzite. Later block faults have displaced the reverse fault plane, leaving the east portion elevated in relation to the west portion. Overthrust sheets of smaller size were mapped by Ross on the Daisy Black and Wilbert properties.

North of North Creek an overthrust sheet of white quartzite partially overlies the gray dolomite. Undoubtedly other overthrust sheets exist in the area; but they were not mapped because of insufficient time.

The large block faults were responsible for the basin and range appearance of the Lemhi Range. Movement along these faults was probably initiated during early Tertiary and has persisted up to the present. These faults trend roughly parallel to the Lemhi Range and were observed on the west slope. The east slope of the range is apparently a tilted fault-block surface extending from the crest to the Birch Creek valley. This is the impression gained from viewing the range from both sides and from hurried traverses across it.

Block faulting is responsible, in part, for some of the more obvious physiographic and structural features of the range. For this reason they have been given local names as it is felt that they are recognizable features which may be traced fairly easily over the surface.

The Black Canyon fault is the longest of these faults. It has a length of about ten miles. Movement along this plane is responsible for the repetition of the outcrop of the quartzite series, and in places the metamorphic series on the east and above the gray dolomite and shale.

The Great Western and Front faults are not as conspicuous as the Black Canyon fault, but they are readily recognized in the field.

Scarp fault is of short length but is fairly conspicuous, as it can be seen from the highway (See Plate II A). Other than being an undissected escarpment of quartzite, and its alignment with other faults in the region, there is little evidence to indicate its origin as a fault trace. Fairly recent movement is suggested by this escarpment.

The fault following Uncle Ike Creek canyon and the Fallert fault were not studied sufficiently to indicate their true relationships, although they suggest movement of the same nature as the other block faults of the region.

Post mineral faults in the Wilbert Mine have been described by Umpleby, Ross, and Anderson. The faults have displaced the ore body as a series of displacements on the order of ten to twenty feet. The faults within the Wilbert Mine and Scarp fault indicate more recent movement than the larger faults of the region.

ORE MINERALIZATION

Mineralization, as indicated by mines and prospects, is found mainly within the quartzite and gray dolomite masses. The localization of the ore bodies near, and in zones of faulting, suggest that there is a genetic relationship between the block faults and the channels along which ore solutions migrated from their source.

The most favorable zones appear to be in quartzite which has been fractured in and near areas which were more or less carbonized. Carbonization of the quartzite is apparently of secondary origin but whether or not the carbonate was introduced along fractured zones coincident with or preceding ore deposition is a problem requiring further investigation.

Within the gray dolomite, and usually associated with the sandy members, mineralization has been observed near or within fault zones.

More detail mapping of the area, with particular attention given to structural relationships of the rocks and enclosed mineralized areas, must necessarily accompany and follow further prospecting. It is believed that fracture zones and bedding planes within the carbonized quartzite and sandy phases of the gray dolomite are the features which control the localization of the ore bodies. These are the more favorable areas in which to search for ore.

Galena is the principal primary ore mineral of most of the mines and prospects of the region. Sphalerite occurs as a minor constituent in the galena-bearing veins. Copper mineralization may be found along the surface trace of the Black Canyon fault.

---

1Ross, C. F., op. cit., plates 1 & 2.
2Umpleby, J. B., op. cit. p. 115.
3Ross, C. F., op. cit. pp. 6-7.
A. Front fault scarp as viewed from northwest.

B. Contorted coral limestone on Crest of Lemhi Range Saddle Mountain, right.
All of the lead-containing outcrops are weathered at and near the surface to a white or light gray sandy lead carbonate (cerussite) with minor amounts of sulfate (anglesite).

The cerussite, locally called "gray lead" or "sand carbonate," is a heavy, white to gray material having a somewhat pearly or resinous luster. It is of surprisingly wide occurrence and is found in the outcrops of all ore bodies. It is often mined as an ore of lead and may contain native silver if the primary galena was silver-bearing. Prominent outcroppings of cerussite occur on the Great Western and Wilbert ore bodies. Anglesite is not abundant in the region, although it was noted as a white to gray, somewhat nodular material.

On the Sentinel property, wulfenite (lead molybdate) occurs rather sparingly. It is found as tabular, pale yellowish plates.

Small pockets of orange and yellow lead oxides also occur at the Sentinel. These minerals are probably massicot and minium.

An outcrop of smithsonite (zinc carbonate) was observed near the Johnson property. This mineral usually occurs as nodular, crystalline incrustations.

The carbonates of copper are the weathered products of copper-bearing minerals and may constitute ore. Bright green malachite and azure-blue azurite are the copper carbonates which occur in the outcrops of copper minerals in this district.

DESCRIPTION OF MINING PROPERTIES

AJAX

This property is located in Sec. 21, T. 7 N., R. 29 E., on the south side of South Creek canyon. The country rock is a white quartzite which is in part carbonatized. Fractures trend in a general northeast direction and show striations in all directions. The dip of the fractures varies from horizontal to vertical. Galena mineralization occurs as fracture fillings and small masses up to a few inches in diameter as replacements in carbonatized quartzite. Carbonatization of the fault gouge is a common feature. Some copper mineralization accompanied the lead.

Workings consist of some 500 feet of drift and a few surface cuts.

Structurally, the mineralization is localized within fractured zones in the quartzite.

BUCKHORN

This property is often referred to as the Bighorn. It is located in Sec. 17, T. 8 N., R. 29 E. and is in the area known as the Metta Basin, northwest of Gloved Peak.

The ore body is a bedding plane replacement of a carbonatized quartzite member of the black siliceous shale series. It has a maximum width of about ten feet exposed at the surface. The ore minerals are galena, barite, and smithsonite. Limonite is fairly abundant. Quartz veins were noted extending through the ore body and following fault planes of relatively small displacement. A small amount of deposition took place along these vertical planes, but the principal deposition occurred as replacement in the carbonatized quartzite.

Although no igneous rock was noted in the immediate area, the country rock appears to have been affected by hydrothermal solutions.

The vein has been opened for a distance of about 500 feet along the strike and about 200 feet down the dip. At the time of the visit, the workings were inaccessible.

COPPER MOUNTAIN

This property lies within Sec. 8, T. 8 N., R. 29 E. on a south branch of Uncle Ike Creek. The ore consists principally of malachite with possible small amounts of galena and lead carbonate. Several tunnels and surface openings had been driven, but they are now caved at the surface. Sorted ore on the dumps indicated that the ore occurs as fracture fillings and bedding plane replacements in the gray dolomite directly overlying white quartzite. It is possible that the Black Canyon fault extends as far north as this property although no detailed mapping was done in the vicinity of this prospect.

DAISY BLACK

The Daisy Black lies in Sec. 32, T. 8 N., R. 29 E. Extensive tunnels and surface workings, now largely caved, mark this locality which was the original outcrop discovery of the present Wilbert ore body. The ore occurs partly in a carbonatized member of the white quartzite and in part along an overthrust
fault plane. The mineralization and structural relationships have been described by Umpleby\(^2\), and Ross\(^3\), and Anderson\(^4\). No work other than a cursory surface examination was done at the Daisy Black.

**GREAT WESTERN**

This property lies in Sec. 8, T. 7 N., R. 29 E. It has been briefly discussed by Umpleby\(^2\) and was given a quick examination at this time. The mineralization occurs in a carbonatized zone of white quartzite about 300 feet thick. Deposition occurs on the west wall of the Great Western fault and within the zone of movement. The ore consists essentially of argentiferous galena. Some copper-stained outcrops were noted.

**JOHNSON PROPERTY**

This property lies in Sec. 29, T. 8 N., R. 29 E. Both Ross\(^3\) and Umpleby\(^2\) mention this property. Galena and smithsonite occur as replacement deposits within a bed of carbonatized quartzite which in turn lies in the gray dolomite near the contact with the underlying quartzite. There are about 500 feet of workings some 50 feet of which is an inclined shaft.

The smithsonite outcrop described by Umpleby\(^2\) occurs in this same bed of carbonatized quartzite several hundred yards to the southeast at the main workings.

**PROTECTION**

The Protection is in Sec. 27, T. 7 N., R. 29 E. The workings consist of about 100 feet of drift along the strike of the Black Canyon fault. On the east side or hanging wall side of the fault is white quartzite and on the footwall side, gray dolomite. A slight amount of mineralization was noted in the fault gouge which consisted of limonite with some lead and copper mineralization.

**SENTINEL**

This property lies in the North Creek canyon about one mile upstream from the Wilbert camp. It is in Sec. 38, T. 8 N., R. 29 E. Mineralization exposed by the workings consists of galena, sphalerite, cerussite, smithsonite, and wulfenite. The ore body is a replacement deposit following in part the bedding planes of the dolomite and partly the west branch of the Black Canyon fault. Development work consists of approximately 150 feet of drift, 50 feet of cross-cut at a lower level, and about 50 feet of raise connecting the two levels.

**WHITEBIRD**

This property lies in the Metta basin, Sec. 17, T. 8 N., R. 29 E. It is near the northward projection of the Black Canyon fault in the shaly limestone formation. Mineralization occurs in a vertical fault zone which trends approximately east-west. The ore consists of galena in a gangue of barite. The ore body is somewhat irregular in shape, being more or less spotted along the fault zone and extending for short distances along the limestone beds on either side. The workings consist of a 110-foot shaft and a 100-foot cross-cut farther down the hill. The two workings are not connected. At the bottom of the shaft, the breccia zone is wider than it is nearer the surface, although the values are not as apparent. Considerable limonite is found in the bottom of the shaft.

The existence of the mineralized fault plane suggests that this structure may have been the course along which the ore solutions migrated from depth. This fault plane can be traced into the siliceous black shale formation where wider zones of limonite stained material are found.

**WHITEROCK**

This property lies in Sec. 34, T. 7 N., R. 29 E. Mineralization consists of galena in the fractured white quartzite and is associated with east-west trending shear zones. Striations along the fault plane are horizontal.

\(^2\)Umpleby, J. B., op. cit. pp. 115-117.
\(^3\)Ross, C. P., op. cit. pp. 7-12.
\(^4\)Anderson, A. L., op. cit.
\(^7\)Umpleby, J. B., op. cit. p. 117.
\(^8\)Umpleby, J. B., op. cit. p 117.
VERTICAL PROJECTION

STRIAE AT 30° FROM HORIZONTAL

PLAN

SENTELINEL MINE
SCALE 1" = 20'

FIGURE NO. 4
[18]
A. Wilbert Mine, North Creek canyon.

B. North Creek canyon at left with Daisy Black working at right and above.
The Wilbert is connected by underground workings to the Daisy Black, and mining is at present progressing in the lower extensions of the Daisy Black ore body. Umpleby, Ross, and Anderson have described the property in some detail. The paragenesis of the ore and gangue material has been studied and described by the previous investigators, and their observations will apply, at least in part, to the other ore deposits of the region.

RECOMMENDATIONS FOR FURTHER PROSPECTING

Within the mapped area it was noted that, with the exception of the Buckhorn and Whitebird, the ore mineralization occurred within the areas of the gray dolomite and quartzite series.

It was further noted that the mineral occurrences were in or near the block fault zones, suggesting that these zones offered passageway for migratory mineral bearing solutions. The zones of the Black Canyon fault and the Great Western fault shown on the accompanying geologic map illustrate this localization.

Carbonatization along fault zones, in the upper white quartzite, and in sandy lenses of the gray dolomite, seems to indicate areas in which mineralization is most likely to occur. The processes of carbonatization and mineralization by epithermal solutions are suggested as occurring along similar passageways.

It is believed that further examination of the block fault zones and areas of carbonatization in the gray dolomite and upper white quartzite will disclose new ore bodies. Careful surface examination, together with selected methods of geophysical prospecting, should be considered.

The products of weathering of galena and sphalerite ore bodies consist principally of lead and zinc carbonates. Sulfates of these metals were not observed as major portions of any of the ore bodies. As these products resemble to some extent dolomite and carbonized quartzite in general appearance, the prospector must be especially alert and not overlook their presence.

---

Umpleby, J. B., op. cit. pp. 116-117.
Ross, C. P., op. cit.